Ames Research Center

Ames Research Center FY99 Implementation Plan

Celebrating 60 Years of Excellence

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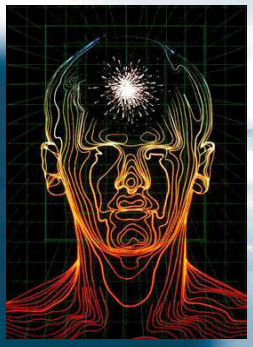
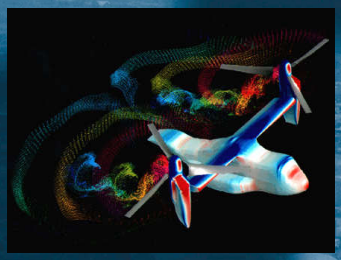
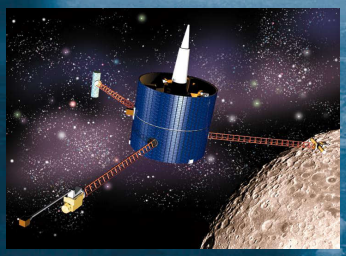


Human Centered Computing



Computational Fluid Dynamics



Lunar Prospector

Pioneer

Air Transportation System

1969 1979 1989 1999

Ames Research Center FY99 Implementation Plan

Implementing NASA's Stategic Plan

with respect to

Center of Excellence,
Center Missions, and
Lead Center Programs and Responsibilities

A Roadmap for Ames' Customers and Employees

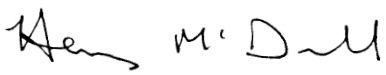
January 1999
Ames Research Center
Moffett Field, CA 94035

A Message from the Ames Center Director

These are exciting times at Ames Research Center. In the last 12 months, the work performed by Ames personnel has expanded our understanding of the universe, made civil aviation cheaper and safer, and advanced the state of the art of information technology. I am proud of all that we have accomplished and envision similar feats in the future. From a managerial perspective, I am also proud of how the Center has aligned its work with the goals and objectives established for NASA and its Enterprises. By delivering on our promises, we've ensured that the Nation is getting a return on its investment in NASA.

Last year, our Center's promises were documented in Ames' first Center Implementation Plan, released in October 1997. The Center Implementation Plan details how Ames Research Center pursues the goals of the NASA Strategic Plan in the everyday work that we do at the Center. This year, we've revised the Plan to make it easier to navigate through and to reflect the current fiscal year's objectives.

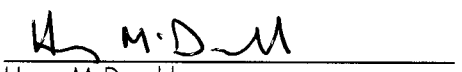
I'm pleased in the way this document has evolved into a useful management tool. I plan to use this document to help me lead this Center into the new millennium and I expect each manager and supervisor at Ames to do the same. I also ask all employees to read this Plan and to know what is expected of them and of Ames. For fiscal year 1999, each employee of the Center is expected to include one of the goals stated in this Plan in his or her performance plan. We are committed to the idea that all Ames employees should be able to trace their job functions and performance back to the Center Implementation Plan and the NASA Strategic Plan. The success of Ames hinges on our ability to fulfill the goals outlined in this Plan.



Henry McDonald
Center Director
Ames Research Center

AMES MANAGEMENT TEAM CONCURRENCE

We, the senior management team of Ames, are committed to working with the men and women of the Center and with our stakeholders, partners, and customers to implement this plan.

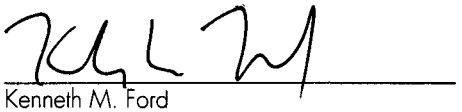


Henry McDonald
Director

William E. Berry
Deputy Director

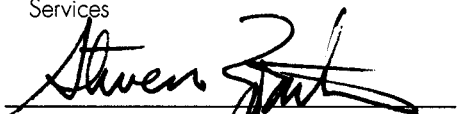
Robert J. Hansen
Deputy Director for Research

Robert Rosen
Associate Director for Aerospace Programs
(Acting) Director of Aeronautics

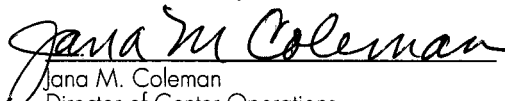


Kenneth M. Ford
Associate Director for
Information Technology

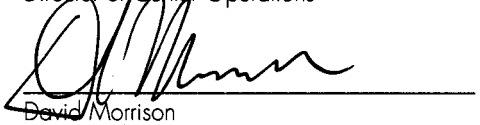
Nancy F. Bingham
Assistant Director for Planning
(Acting) Director of Research and Development Services



Steve F. Zornetzer
Director of Information Systems

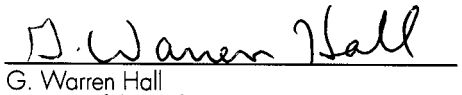


Jana M. Coleman
Director of Center Operations

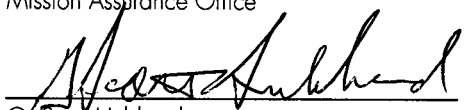


David Morrison
Director of Space

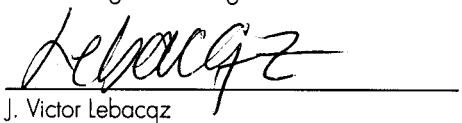
Lewis S. G. Braxton, III
Chief Financial Officer



G. Warren Hall
Director of the Safety, Environmental, and
Mission Assurance Office

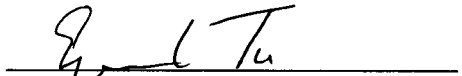


G. Scott Hubbard
Astrobiology Institute Interim Manager
SOFIA Program Manager



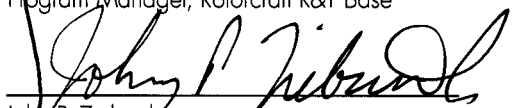
J. Victor Lebacqz
Director, Aviation Operations Systems
Program Manager, Aviation System Capacity

Maurice M. Averner
Program Manager, Gravitational Biology
and Ecology



Eugene L. Tu
Program Manager, High Performance
Computing and Communications
(Acting) Program Manager, Information
Technology R&T Base

Joe W. Elliott
Program Manager, Rotorcraft R&T Base



John P. Ziebarth
Director, Consolidated Supercomputing
Management Office

Joseph L. Conley
Director, Simulation Facility Group

TABLE OF CONTENTS

I. INTRODUCTION

This document presents the strategic implementation plan for Ames Research Center. It describes how Ames intends to implement its Center of Excellence responsibilities, Agency assigned missions, Agency and Enterprise lead programs, and other roles in support of NASA's vision and mission.

All Federal agencies are required by the 1993 Government Performance and Results Act to implement a long-term strategic planning process that includes measurable outcomes and strict accountability. At NASA, this planning process is shaped by the Space Act of 1958, annual funding, appropriations, and other external mandates, as well as by customer requirements. The resulting Strategic Plan sets the overall architecture for what we do, identifies who our customers are, and directs where we are going and why. The Strategic Plan is the basis upon which decisions regarding program implementation and resource deployment are made.

Whereas the *strategic planning process* examines the long-term direction of the organization and identifies a specific set of goals, the *implementation planning process* examines the detailed performance of the organization and allocates resources toward meeting these goals. It is the purpose of this implementation document to provide the connection between the NASA Strategic Plan and the specific programs and support functions that Ames employees perform. This connection flows from the NASA Strategic Plan, through the various Strategic Enterprise plans to the Ames Center of Excellence, primary missions, Lead Center programs, program support responsibilities, and ultimately, to the role of the individual Ames employee.

II. Vision, Mission, Goals, and Values

NASA Vision and Mission

Vision

NASA is an investment in America's future. As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.

Mission

- *To advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe, and use the environment of space for research.*
- *To explore, use, and enable the development of space for human enterprise.*
- *To research, develop, verify, and transfer advanced aeronautics, space, and related technologies.*

Meeting the NASA Mission

NASA uses a variety of means to organize and focus the efforts of the Centers to achieve Agency missions. The primary organizations and initiatives are Strategic Enterprises, Centers of Excellence, Center Missions, and Lead Centers for technical programs.

Strategic Enterprises

NASA has established the four Strategic Enterprises to function as primary business areas for implementing NASA's mission and serving customers. Each Enterprise has a unique set of strategic goals, objectives, and implementing strategies that address the requirements of the Agency's primary customers. NASA's Centers define how Enterprise programs and central services will be developed and delivered to external and internal customers.

The four NASA Strategic Enterprises are:

- *Aero-Space Technology*
- *Space Science*
- *Human Exploration and Development of Space*
- *Earth Science*

Centers of Excellence

Centers of Excellence are focused, Agency-wide leadership responsibilities in a specific area of technology or knowledge. They must strategically maintain or increase the Agency's preeminent position in the assigned area of excellence in line with the program requirements of the Strategic Enterprises and the long-term strategic interests of the Agency. A designation of Center of

Excellence brings to the Center the charge to be preeminent within the Agency, if not worldwide, with respect to the human resources, facilities, and other critical capabilities associated with the particular area of excellence.

The Ames Center of Excellence is:

- *Information Technology*

Center Missions

Center missions identify the primary concentration of capabilities to support the accomplishment of Strategic Enterprise goals. Each Center has designated areas of mission responsibility, which provide a basis for building human resources capabilities and physical infrastructure in direct support of Enterprise requirements.

The Ames missions are:

- *Astrobiology*
- *Aviation Operations Systems*

Lead Center Programs

Each NASA program is assigned to a Lead Center for implementation. Lead Center Directors have full program management responsibility and authority, and thus, full accountability for assigned missions or programs, ensuring that they are being managed to agreed-on schedule milestones, budget guidelines, technical requirements, and all safety and reliability standards.

The Ames Lead Center Responsibilities in support of Agency Programs are:

- *High-Performance Computing and Communications (HPCC)*
- *Consolidated Supercomputing Management Office (CoSMO)*
- *Intelligent Systems (IS)*
- *Information Technology Security (ITS)*

The Ames Lead Center Responsibilities in support of the Enterprises are:

- *Information Technology R&T Base Program*
- *Rotorcraft R&T Base Program*
- *Aviation Operations Systems R&T Base Program*
- *Aviation System Capacity Program*
- *Simulation Facility Group Director*
- *Stratospheric Observatory for Infrared Astronomy (SOFIA) Program*
- *Gravitational Biology & Ecology Program*

Institutional Support

In addition to these organizations, Ames has many institutional systems that support the Center of Excellence, missions, lead center programs, and other research and technology development activities. These systems are essential for Ames to meet its programmatic commitments and for operation of the Center.

Ames Research Center Mission, Approach, and Values

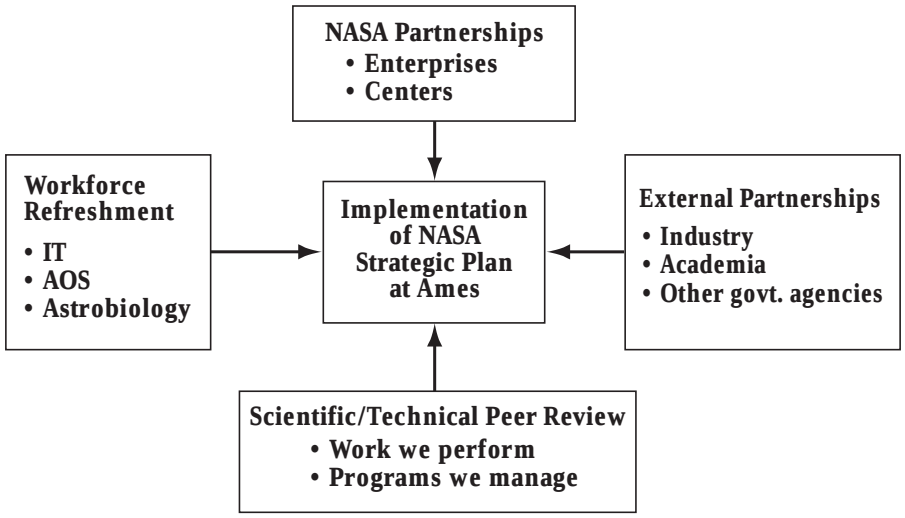
Mission

- *As NASA's Center of Excellence for Information Technology, to lead and coordinate research encompassing the fields of high-performance computing and networking, human-centered computing, and automated reasoning.*

- *As NASA's lead center for Astrobiology, to develop science and technology requirements for current and future flight missions that are relevant to astrobiology, including advanced concepts and technology development; to identify and develop astrobiology mission opportunities, life sciences experiments for spaceflight, and space science research components of astrobiology; and to lead in information technology applications and astrobiology education and outreach programs that inform and inspire the American public.*

- *As NASA's lead center for Aviation Operations Systems, to champion research efforts in air traffic control and human factors; to lead the Agency's research efforts in rotorcraft technology; and to create design and development process tools, and wind tunnel and simulation facilities.*

Approach



Values

Ames' management and supervisors recognize that people are the organization's most important asset. To ensure a work environment that accurately reflects that belief, Ames encourages and promotes adherence to the following core values:

RESPECT

We have respect for the individual and for diversity in culture, background, and experience. We maintain the highest principles of fairness and equitable treatment of all employees.

COMMUNICATION

We recognize that only through open and honest communication will our goals be achieved.

TEAMWORK

We believe in cooperative interaction among ourselves and others. By working together with respect, trust, and mutual support, we achieve common goals.

CREATIVITY

We foster creativity, ingenuity, and innovation in our endeavors.

INTEGRITY

We maintain the highest principles of integrity, honesty, and accountability.

EXCELLENCE

We continually strive to improve. We demand professionalism in our conduct and excellence in our products.

CUSTOMER FOCUS

We are responsive to our customers and satisfy their requirements.

RESPONSIBILITY

We are responsible stewards of the public interest, public resources, and the public trust.

RELEVANCE

We ensure that all our endeavors are aligned with national needs and the Agency vision and purpose.

DISCOVERY

We are bold, but prudent, as we expand the boundaries of scientific understanding and technical knowledge in air and space.

III. Implementing Agency-Level Responsibilities

NASA'S Center of Excellence for Information Technology (COE-IT)

COE-IT Description

NASA's missions in space exploration and aeronautics will require advances in many areas of science and technology, but most critical among these enabling technologies will be that collection of technologies known as information technology (IT). To ensure that NASA fully exploits this most critical enabling technology, the Ames Research Center has been designated the NASA Center of Excellence for Information Technology. Because of both its long history of computer science research excellence and its location in the heart of Silicon Valley, the Ames Research Center was the logical place for NASA to focus its IT research program. The Ames Research Center has embraced its responsibilities as the NASA Center of Excellence for Information Technology and accepted the challenge of excellence.

COE-IT Focus Areas

During the past two years, the COE-IT has led an effort to understand NASA's future IT requirements and the concomitant research investments necessary to meet them. In addition, COE-IT and its various review committees (including academic and industrial advisors) have assessed both NASA's research processes and its relative strengths and weaknesses. As described in the new multicenter document titled "Information Technology at NASA: Accepting the Challenge of Excellence," this study has identified three IT research cornerstones upon which NASA can build its future:

(1) Automated Reasoning for Autonomous Systems

NASA's mission of space exploration coupled with the Administrator's challenge to do it "faster, better, and cheaper" has provided the requirement for one of the most stressing applications facing the computer science research community—that of designing, building, and operating progressively more capable autonomous spacecraft and rovers. Research on automated reasoning for autonomous systems will enable a new generation of spacecraft to do more exploration at a much lower cost than traditional approaches. An impressive early example of this technology (Remote Agent Autonomy Architecture) will demonstrate its usefulness on the Deep Space One (DS-1) mission.

(2) High-Performance Computing and Networking

NASA has a long history of leadership in high-performance computing for both scientific and engineering applications. Today the field of high-performance computing is changing rapidly: on the high end, new architectures are under development that combine the performance gains of massively parallel computing with the flexibility of shared-memory multiprocessor approaches; on the low end, powerful microprocessor-based systems are now performing computations that would have required a supercomputer until very recently; and finally, the advent of high-speed connectivity is making the slogan "the network is the computer" true for more and more applications. Toward this end, NASA is playing an important role in the NGI (Next-Generation Internet) project, which will develop networks that are 100 to 1000 times faster than today's Internet.

(3) Human-Centered Computing

The emerging concept of "human-centered computing" represents a significant shift in thinking about information technology in general, and about intelligent machines in particular. It embodies a "systems view," in which the interplay between human thought and action and technological systems is understood as inextricably linked and an equally important aspect of analysis, design, and evaluation. Within this framework, NASA researchers are inventing and deploying sophisticated computational aids designed to amplify human cognitive and perceptual abilities. Essentially these are cognitive prostheses, computational systems that leverage and extend human intellectual capacities, just as the steam shovel was a sort of muscular prosthesis.

By building on these three research cornerstones, IT will enable a wide range of applications and missions, some of which we can only dimly glimpse today. Over the last year, the Ames Research Center has identified five mission-critical application areas, with the objective of transforming them through application of advanced IT:

(1) Robotic Exploration of Space

The next generation of robotic explorers must exhibit an unprecedented level of autonomy. They will need to be smart, adaptable, curious, and self-reliant in harsh and unpredictable environments. Research on automated reasoning for autonomous systems will enable a new generation of spacecraft to do more exploration at a much lower cost than traditional approaches.

(2) Aviation Operations

The projected growth in air traffic over the coming decade will strain our already congested air traffic and ground management systems, producing an unacceptable number of accidents if uncontrolled. NASA, in collaboration with the Federal Aviation Administration (FAA), is developing advanced IT systems that will play a major role in realizing the twin goals of safer aircraft operation and higher throughput of the airport and

ground control infrastructure. For example, a new generation of cognitive and perceptual prostheses are being considered to assist pilots and air traffic controllers.

(3) Science Data Understanding
NASA is responsible for launching and gathering data from progressively more sophisticated orbital and deep space instruments. For example, the Earth Observing System (EOS) is being deployed to monitor global climate change. When fully operational, the sensor-rich satellites will generate about one terabyte of data per day. Equally important as the need for progress in high-capacity data storage and dissemination schemes is the development of tools aimed at facilitating human understanding of these immense data sets. On the opposite end of the data generation spectrum, distance greatly limits the ability of the space science community to fully exploit the presence of our machines on remote planets. Emerging research results from the three NASA IT cornerstones will better enable scientists to understand our world as well as distant worlds.

(4) Design & Manufacturing in the Virtual Environment
The future missions of NASA, such as Mars exploration, involve uniquely difficult design and engineering challenges. Early in the design cycle, complex trade-offs between spacecraft characteristics and mission concepts must be performed in the virtual environment by geographically distributed teams of experts. As mission and platform design proceeds, detailed evaluations of cost and performance impacts associated with utilizing advanced technologies are required. To address these challenges, NASA researchers are exploiting all three of our IT cornerstones.

(5) Human Exploration of Space
A critical requirement for NASA is to reduce the cost of operating in space. Advanced information technology research permits dramatic reductions in launch and operational costs of spaceflight systems. For example, as humans contemplate journeys to Mars and beyond, research requirements clearly exist for developing a wide range of performance support systems, diagnostic systems, condition-based maintenance systems, and a wide range of other systems that operate autonomously or semi-autonomously in support of mission requirements.

COE-IT Implementation Strategy

Ames Research Center has committed itself to taking the actions necessary to meet its responsibilities as the NASA Center of Excellence for Information Technology. The Ames Independent Verification and Validation (IV&V) Facility, which works to ensure the quality, safety, reliability, cost, and performance of software, is a key contributor to this effort. The Ames IV&V Facility is committed to providing the highest quality, mission critical software throughout NASA and to managing projects in its six strategic business areas: Systems and Software IV&V; Applied Software and Systems Engineering Research; Software Measurement; Software Independent Assessments; Educational

Outreach; and Technology Transfer. In these strategic business areas, the Ames IV&V Facility uses its expertise to help each mission critical application area meet the challenge of "better, faster, and cheaper," and to partner with industry and academia to increase ARC's understanding of software engineering processes.

ARC has also embarked on a multifaceted strategy aimed at improving the quality and relevance of its IT research program. Developed in consultation with its various COE-IT review and advisory committees, this strategy includes the following thrusts:

- Recruit a reputable IT senior management team.
  Over the last two years ARC has totally rebuilt its senior and midlevel IT management team. This restructuring included an Associate Center Director for IT to lead the COE-IT effort, and Directors for the Information Systems Directorate and the Consolidated Supercomputing Management Office (CoSMO). Midlevel managers include Division Chiefs for the Computational Sciences Division; the Numerical Aerospace Systems Division; the Aviation Systems Research, Technology, and Simulation Division; and the Aeronautical Information Technology Division. These new hires came from academia, government (Office of Naval Research (ONR)), and Silicon Valley industry.

- Recruit a critical mass of first-rank IT researchers.
  Ames has aggressively recruited the best computer scientists (over 100 in the last two years) available nationwide—researchers who comprise the intellectual engine that will drive NASA's IT research now and in the future.

- Create an "excellence-driven" research environment.
  To preclude losing fine scientists because of an unproductive or unsupportive work environment, Ames has made strong strides in building a research climate that values scientific and technical excellence and that allocates resources on that basis. First, a rigorous peer review system is now in place for all IT programs performed or managed at Ames. Given NASA's limited resources, it is important that it perform only technically competent and strategically relevant IT research. Perhaps equally important, good researchers prefer their work to be assessed by technically competent reviewers rather than the alternative, which often promotes partisanship. Additionally, COE-IT has formed an IT steering committee comprising senior national leaders in IT who performed a thorough assessment of NASA-wide IT needs and capabilities.

- Encourage and solicit collaboration with the best.
  NASA cannot afford to "go it alone" in IT research and must learn to eradicate the "not invented here" mentality. Toward this end, COE-IT will continually assess relevant research in industry, government, and academia to identify potential areas of collaboration. To facilitate these collabora-

tions, ARC has recruited a focused team of professionals (representative of industry, government, and academia) that includes a Silicon Valley CEO, a recently retired Vice Admiral, several university personnel, and a full-time collaboration manager. Thus far, ARC has over 130 IT-related research partners in industry and government. Additionally, ARC is increasing its university-based research and is building particularly strong relationships with key university partners.

In summary, ARC will constantly work to earn and re-earn the COE designation. To remain worthy of the designation, the ARC IT community must continue to critically assess its progress and strive toward consistently delivering strategic IT research programs that are not only of the highest technical quality, but strongly enabling with respect to NASA's future missions. Significant progress in this direction has been made.

Ames' Mission Assignments

Astrobiology

Mission Description

Astrobiology is defined in the NASA Strategic Plan as the study of the living universe. Astrobiology studies are multidisciplinary and are directed toward understanding:

- Origin of life—*how life began in the context of the formation and diversity of planetary systems.*
- Evolution of life—*the co-evolution of life and the planetary environment, and the limits of life.*
- Distribution of life—*the search for other biospheres (past or present) in our solar system and beyond.*
- Destiny of life—*how life may adapt to our changing environment and to other environments beyond the Earth.*

The designation of Ames as the Agency lead in Astrobiology recognizes Ames' historical strength in multidisciplinary research in the Life, Space, and Earth sciences, and Ames' unique involvement in all of NASA's Strategic Enterprises. Subsequently, Ames was also designated as the lead for Astrobiology by the Space Science, Earth Science, and Human Exploration and Development of Space Enterprise Offices. In 1997, Ames was assigned the closely related Life Science Program Office for Gravitational Biology and Ecology. In 1998, Ames was assigned the Space Science Program Office for Astrobiology. This designation requires that the Center exercise scientific and technological leadership in this field for the benefit of the entire scientific community. Ames also provides the principal support to the Office of Space Science in managing its astrobiology program, including the host function and operations management for the NASA Astrobiology Institute (described later).

Mission Focus

Astrobiology is a new term for a broad, multidisciplinary field linking the NASA space program with the biological sciences. Recent discoveries about life, the environment, and the potential for life elsewhere, when coupled with the dramatic advances in technological tools and mission capabilities over

the past decade, allow us to hope to answer long-held questions about the living universe, and to explore significant new ones. The over-arching questions include: Where did we come from? Are we alone? and What is our future on Earth and in space?

Six basic science questions define the current scope of astrobiology research. These questions were articulated at the first NASA Astrobiology Workshop in 1996 and reaffirmed (and slightly modified) in 1998 as part of the development of the NASA Astrobiology Roadmap:

- *How do habitable worlds form and evolve?*
- *How do living systems emerge?*
- *How can other biospheres be recognized?*
- *How are biological evolution and the development of planetary environments related?*
- *How do ecosystems respond to environmental changes on time scales relevant to human civilization?*
- *What is the potential for survival, adaptation, and biological evolution beyond the home planet?*

Efforts to answer these questions form the initial complement of research and development activities in astrobiology. Progress requires access to data from airborne and space missions and integration of the knowledge, technologies, and mission capabilities available through NASA's four Strategic Enterprises. In return, advances in astrobiology will provide new insights and capabilities to astrobiology's parent programs in a relationship that is inherently symbiotic.

Implementation Approach

- Research
  Ames scientists will carry out basic research, participate in flight missions, and facilitate participation of the national science community in astrobiology. To implement the Agency's Center Mission effectively, Ames will develop its research staff and facilities to maintain technical excellence across the range of disciplines encompassed by astrobiology.

- Strategic Planning
  Ames will lead in the development of a NASA Astrobiology Roadmap, bringing together the science and technology communities to identify research priorities and translate these into appropriate NASA programs, technology challenges, and flight missions. Through its Center for Mars Exploration, Ames will also continue to support planning for the NASA Integrated Mars Exploration Program.

- Operation of Facilities
  Ames will define, develop, and operate major research facilities for the benefit of the scientific community. These include flight operations for Life Science payloads on the Space Shuttle, operation of a suite of centrifuge facilities under the Center for Gravitational Biology, and development of the SOFIA airborne observatory and the Space Station Biological Research Facility for use by the science community in the next century.

- Mission Planning & Technology
  Ames will lead the effort to identify astrobiology opportunities on NASA's current missions, ascertain the key technology needs for future ground and flight research in astrobiology, and develop advanced mission concepts to meet astrobiology's far-ranging science goals. Recognizing the broad range of mission and technology expertise throughout and beyond NASA, Ames will continue to involve all relevant field centers as well as external expertise in academia and industry in obtaining the greatest scientific and mission results in the shortest time possible and for the lowest cost.

- Outreach and Education
  In recognition of the widespread public interest in astrobiology-related questions, web-based public education and outreach efforts will be key features of the Ames program. Ames will develop plans to link astrobiology researchers with educators and communicators to ensure the technical accuracy and relevance of NASA education and outreach products.

- NASA Astrobiology Institute
  The NASA Astrobiology Institute (NAI), managed by Ames Research Center, has been formed to carry out world-class, multidisciplinary research on a wide range of fundamental science questions in the field. The NAI is a virtual institute, whose members continue to reside at their home institutions, utilizing state-of-the-art communications technologies and tools, eventually to include the NASA Research Network / Next-Generation Internet, to enable collaborative interactions. NASA has charged the NAI with helping to coordinate and catalyze astrobiology across a range of disciplines and organizations; developing and demonstrating modern communications technologies in support of multidisciplinary research; providing advice to and technologies for NASA missions; training students; and providing outreach to the general public. The Director and management staff reside at Ames. NAI operation is guided by an Executive Council, formed from representatives of each lead institution. A tight relationship is maintained between the NAI and information technology organizations at Ames in order to promote the development, implementation, and demonstration of communications technologies.

Aviation Operations Systems (AOS)

Mission Description

Aviation Operations Systems (AOS) is the mission assigned to Ames by the Agency in recognition of Ames' history of contributions in flight management, air traffic management automation, and aviation human factors, as well as in the airborne technologies of guidance and control. Aviation Operations Systems are defined as those ground, satellite, and aircraft systems and human operators that control the operational safety, efficiency, and capacity of aircraft operating in the airspace. AOS studies specifically encompass:

- *Communication, navigation, and surveillance (CNS) systems;*
- *Air traffic management systems, interfaces, and procedures;*
- *Relevant cockpit systems, interfaces, and procedures;*
- *Operational human factors, their impact on aviation operations, and error mitigation;*
- *Weather and hazardous environment characterization, detection, and avoidance systems.*

Mission Focus

The program investment strategies that contribute to the Aero-Space Technology Enterprise outcome goals of Safety and Capacity are based on the report "Toward a Safer 21st Century, Aviation Safety Research Baseline and Future Challenges" (Huettner, C.H., NASA NP 1997-12-231-HQ, December 1996). This report suggests three general areas for safety research focus: Aircraft / Aviation System, People, and Environment. These areas can be further generalized to address both safety and capacity as:

- *System Design, Assessment, and Reliability*
- *Human Performance and Deficit Countermeasures*
- *Hazardous Environment Prediction and Mitigation*

Implementation Approach

- Research
  Ames will conduct basic and applied research in aviation operations systems through the Aviation Operations Systems Base R&T program, which it leads for the Agency, and through specific Systems Technologies research programs, such as the Aviation System Capacity Program for which it is the Enterprise Lead Center, and the Aviation Safety Research Program, for

which it plays a support role. To implement its Center mission effectively, Ames will develop its research staff and facilities to maintain technical excellence across the range of disciplines encompassed by aviation operations systems, specifically automation science, human factors, and information technology.

- Strategic Planning
  Ames will lead in the development of a NASA Throughput Roadmap, bringing together the appropriate customer communities to identify research priorities and translate these into appropriate NASA programs and technology challenges.

- Operation of Facilities
  Ames will define, develop, and operate major research facilities, as appropriate, to support research in Aviation Operations Systems. These include simulators and laboratories devoted to ATM automation and human factors.

- Customer Outreach
  The Aviation Operation Systems Subcommittee is the prime, formal interface with the customer community regarding customer feedback and requirements for AOS programs. Additionally, informal interaction takes place through cooperative programs with the AOS customer community. The FAA, as the prime government customer, provides its input through numerous joint programs and the FAA / NASA Coordinating Committee. Appropriate collaborative research is also assured by an Interagency Integrated Product Team formed under a formal Memorandum of Understanding.

Ames' Lead Center Roles for Agency-Wide Programs

High-Performance Computing and Communications (HPCC) Program

NASA's HPCC Program is an integral part of the Federal Computing Information and Communications (CIC) program (formerly the High-Performance Computing and Communications Program). The main goal of the Federal CIC Program is to accelerate the development and use of high-performance computers and networks in the Federal government and throughout the American economy. These resources are essential to national competitiveness and will enable the United States to strengthen and improve the environment and civil infrastructure, digital libraries, and remote sensing databases, as well as education and lifelong learning, health care, manufacturing, and national security.

FY99 Objectives

The primary objectives of the HPCC Program, as implemented at Ames, are to:

- *Improve time to solution for a Grand Challenge problem by 200 times the 1992 baseline using a 10^{12} floating point operations per second (TeraFLOPS) testbed;*
- *Demonstrate educational applications of computing and communications technologies;*
- *Actively participate in the President's NGI initiative.*

Approach

The NASA HPCC Program is structured to contribute to broad Federal efforts while addressing Agency-specific computational problems that are beyond near-term projected computing capabilities. The Program manages work at ten NASA field centers in support of research and development needs and cross-cutting educational applications of computing technology for all the NASA Strategic Enterprises. Current projects include: the Computational Aerosciences (CAS) project, the Earth and Space Sciences (ESS) project, the Remote Exploration and Experimentation (REE) project, the Learning Technologies (LT) project, and the National Research and Education Network (NREN) project.

In the next three to five years, the overall goals of the HPCC will be to:

- *Develop algorithm and architectural testbeds that use high-performance computing and networking concepts and increase end-to-end performance.*
- *Develop high-performance computing architectures scalable to sustained performance at TeraFLOPS.*

- *Develop and demonstrate next-generation network testbeds that connect universities and Federal research institutions at rates 100 to 1000 times faster than today's Internet and that enable new applications that meet important national and agency goals.*
- *Demonstrate HPCC technologies on U.S. aeronautics, Earth and space sciences, and spaceborne community research problems.*
- *Develop services, tools, and interfaces essential to distributing technologies to the American public.*
- *Conduct pilot programs in education that demonstrate innovative technologies.*

Consolidated Supercomputing Management Office (CoSMO)

The Consolidated Supercomputing Management Office (CoSMO) is a NASA Chief Information Officer (CIO)-sponsored functional initiative. The primary goal of CoSMO is to meet the High-Performance Computing (HPC) requirements for all Enterprises, while realizing an optimal return on investment through effective and efficient management of NASA's HPC assets. It is responsible for the acquisition, maintenance, operation, management, upgrade, and cost-center budgeting for NASA's supercomputer resources, regardless of location. Operations and maintenance support are provided to NASA research and development and secure-computing programs.

FY99 Objectives

CoSMO objectives for consolidated Agency-wide management of supercomputing are to:

- *Replace the Cray C90 supercomputer "Eagle" with the most cost-effective alternative.*
- *Complete consolidation of Langley Research Center's secure supercomputing at the Naval Oceanographic Office (NAVOCEANO), Stennis Space Center, Mississippi.*
- *Complete its program plan and proposed system architecture.*
- *Continue implementation of "Year 2000" compliance.*
- *Establish an Agency-wide, consolidated operations contract for supercomputing.*

Approach

CoSMO's approach is to evolve NASA's HPC assets toward an environment that embraces the concepts of a "metacenter." This metacenter, in theory, will permit any user of CoSMO to have uniform access to all computing and storage assets associated with CoSMO. The scope of supercomputing resources within NASA includes high-speed processors, mass-storage systems, and network interfaces. Supercomputers include production, research and development, and secure-computing engines.

Longer-term goals for the CoSMO program are to:

- *Consolidate operations across NASA and design an optimal supercomputing architecture to reduce the number of physical locations for supercomputing.*
- *Co-locate supercomputing platforms within large data centers, where applicable.*
- *Modernize data centers to improve service and reduce life-cycle costs.*
- *Outsource supercomputing activities, when cost-effective.*
- *Form partnerships with Centers by using matrix management principles.*
- *Participate in NASA's transition to full-cost accounting methods by designing a market-based approach for the use and costing of supercomputing resources.*

Intelligent Systems (IS)

An essential element in the success of NASA's COE-IT is the strategic investment area, "Intelligent Systems." Its overall objective is to provide NASA with autonomous and semi-autonomous computational capabilities to enable further missions in deep space, planetary exploration, aerospace applications, and earth observing systems and data understanding. Three distinct strategic research components comprise the Intelligent Systems investment area: Automated Reasoning, Intelligent Systems for Data Understanding, and Human-Centered Computing.

Approach

Achieving the capabilities described above will require coordinated investment in both in-house and extramural research with partners in universities, industry, and other NASA Centers. Ames Research Center (ARC) is well-positioned to assume technical leadership and take management responsibility for this strategic investment area. In particular, ARC has internationally recognized leadership in the areas of Artificial Intelligence, Advanced Software Engineering, and Robotic Systems. ARC is building upon these essential core capabilities. Accordingly, ARC is integrating with these core capabilities new and rapidly evolving programs in biomimetrics (e.g., neural networks and neurotechnology) and other nontraditional computational schemes to establish revolutionary new approaches to computing for the next century.

Planned products of the Intelligent Systems Strategic Investment area include:

- *Fully cooperative adaptive Intelligent Agents*
- *Maximized software reuse with automated reasoning toolkit for Systems Engineers*
- *Software-driven hardware physical reconfigurability*
- *Seamless integration of human / machine functions*
- *Haptic / Immersive Interfaces*
- *Tightly coupled hybrid methods enabling fully integrated human / computer interfaces*
- *Hybrid Adaptive Intelligent knowledge discovery and data mining tools to mediate discovery / understanding*
- *Adaptive and Autonomous Sensor-guided motor control for Robotic Systems*
- *Demand-based, shared flexible National Information Power Grid*
- *Biologically inspired solutions to sensor fusion, adaptive decision making, and real-time learning in unstructured environments*

Information Technology Security (ITS)

The Principal Center for ITS (PC-ITS) was established to bring a unified approach and an Agency focus to the problem of information security. The PC-ITS is committed to developing and maintaining a secure, state-of-the-art computing infrastructure that can support the NASA programs and projects as well as NASA researchers throughout the world. This commitment requires a strategy that: prevents information from being disclosed to anyone who is not authorized to use it; prevents information from being maliciously corrupted, modified, or forged; and prevents access from being denied because of burdensome procedures or malicious attacks.

FY99 Objectives

The program objectives are to:

- *Implement a NASA Public Key Infrastructure (PKI).*
- *Deploy an Agency-wide secure messaging system that utilizes the PKI.*
- *Initiate an Agency-wide ITS awareness and training program.*
- *Prototype a certification program for NASA system and network administrators.*

Approach

The approach of the ITS program is to:

- *Update the policies and procedures addressing ITS.*
- *Establish standard metrics and reporting processes for all Centers to follow.*
- *Utilize technologies to help manage the security of the IT environment.*
- *Formalize the ITS program in the Agency budget process.*

Achieving these goals and objectives will require coordinated investment and cooperation at the Agency level and by the other NASA Centers.

IV. Implementing Enterprise-Level Responsibilities

Aero-Space Technology (AT) Enterprise

The Office of Aero-Space Technology (OAT) has developed a set of goals for the future that reflect national priorities for aeronautics and space. These ten goals, outlined in the AT brochure "Three Pillars for Success," are grouped into three areas or "pillars" in order to stress their significance and contribution to America's future. The pillars are Global Civil Aviation, Revolutionary Technology Leaps, and Access to Space. The following sections describe the goals and Ames' involvement in them.

Pillar One: Global Civil Aviation

As the largest positive industrial contributor, aviation products are vitally important to the U.S. balance of trade. Moreover, it is projected that air travel demand will triple over the next 20 years. To preserve our Nation's economic health and the welfare of the traveling public, NASA must pursue high-risk research to provide needed technology advances for safer, cleaner, quieter, and more affordable air travel. Accordingly, the Global Civil Aviation pillar encompasses the following five goals:

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years.*
- *Reduce emissions of future aircraft by a factor of 3 within 10 years, and by a factor of 5 within 25 years.*
- *Reduce the perceived noise levels of future aircraft by a factor of 2 (from today's subsonic aircraft) within 10 years, and by a factor of 4 within 25 years.*
- *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 25 years.*

Pillar Two: Revolutionary Technology Leaps

NASA's charter is to explore high-risk technology areas that can revolutionize air travel and create new markets for U.S. industry. The technology challenges for NASA include: eliminating the barriers to affordable supersonic travel, expanding general aviation, and accelerating the application of technology advances. To meet these challenges, the Revolutionary Technology Leaps pillar strives to meet three goals:

- *Reduce the travel time to the Far East and Europe by 50 percent within 25 years, and do so at today's subsonic ticket prices.*
- *Invigorate the general aviation industry, delivering 10,000 aircraft annually within 10 years, and 20,000 aircraft annually within 25 years.*

- *Provide next-generation design tools and experimental aircraft to increase design confidence, and cut the development cycle time for aircraft in half.*

Pillar Three: Access to Space

NASA envisions the space frontier as a future, busy crossroads of U.S.-led international science, research, commerce, and exploration. NASA's experience with this vast resource has already yielded new treasures of scientific knowledge, life-enhancing applications for use on Earth, and fantastic celestial discoveries. To realize the potential for research and commerce in space, the United States must achieve one imperative, overreaching goal—affordable access to space. Specifically, the third pillar, Access to Space, encompasses two goals:

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 25 years.*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years.*

Ames' Lead Roles in Aero-Space Technology

The goals and objectives of the AT Enterprise are expressed in terms of the three pillars and ten goals described previously. Ames is committed to working with industry and other government entities to develop the technology that will make these goals a reality. Research and development conducted by the AT Enterprise is led by individual NASA research centers according to the primary roles and missions that have been assigned to each Center. Ames is the lead center for the focused programs in Aviation System Capacity (ASC) and High-Performance Computing and Communications (HPCC) and for the Research and Technology (R&T) base programs in Aviation Operations Systems, Information Technology (IT), and Rotorcraft. In addition, Ames leads the Enterprise core competencies in the areas of human factors, air traffic management, information system technologies, integrated aeronautics design tools, and rotorcraft R&T. Other strategic investment areas include critical national research facilities, high-performance computing, environmental research and modeling, and high-performance aircraft survivability.

INFORMATION TECHNOLOGY R&T BASE PROGRAM

The Information Technology R&T Base Program is sponsored by the OAT to develop and transfer information technology solutions that support NASA's missions. It is organized into three program goal areas: Integrated Design Technology, Software Technology, and Advanced Computing Technology.

Program FY99 Objectives

The objectives of the IT R&T Base Program in FY99 are to:

- *Demonstrate integration of intelligent information analysis, computational simulation, and unified instrumentation for design-cycle reduction of aerospace vehicles.*
- *Demonstrate neural-based adaptive flight control technology capable of handling off-nominal flight conditions and system failures.*
- *Demonstrate a prototype homogeneous distributed computing environment to enable collaborative computing.*

Program Approach

The IT R&T Base Program aims to provide fundamental advances in simulation and test techniques, software technology, and advanced, high-end computational capabilities. The first area of Integrated Design Technology focuses on the development of tools and integrated systems for the design and manufacture of flight vehicles. The second area, Software Technology, focuses on the development of flight critical systems. Because these activities, and many others within OAT, rely on ever-increasing computational capabilities, it follows that the third area of Advanced Computing Technology addresses advanced capabilities of computing systems. The unique role of this program is its emphasis on researching integrated supercomputing systems.

Enterprise Goals/ Objectives Served

The primary AT Enterprise goals served by these areas of the IT Program include:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years. (Software Technology)*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 25 years. (Software Technology and Integrated Design Technology)*

Pillar Two: Revolutionary Technology Leaps

- *Provide next-generation design tools and experimental aircraft to increase design confidence, so that the cycle time for aircraft is cut in half. (Integrated Design Technology and Advanced Computing Technology)*

Pillar Three: Access to Space

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 25 years. (Integrated Design Technology, Software Technology, and Advanced Computing Technology)*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years. (Integrated Design Technology, Software Technology, and Advanced Computing Technology)*

ENTERPRISE GOALS/
OBJECTIVES SERVED

The primary AT Enterprise goals served by these areas of the Rotorcraft R&T Base Program are:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years. (FRIAR and SAFOR)*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 25 years. (FRIAR)*
- *Reduce the perceived noise levels of future aircraft by a factor of 2 from today's subsonic aircraft within 10 years, and by a factor of 4 within 25 years. (SILNT)*
- *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years. (FRIAR)*

Pillar Two: Revolutionary Technology Leaps

- *Provide next-generation design tools and experimental aircraft to increase design confidence, so that the cycle time for aircraft is cut in half. (DEAR and FRIAR)*

ROTORCRAFT R&T BASE PROGRAM

The Rotorcraft R&T Base Program is sponsored by the OAT to provide technology leadership in both the short and long term. The program consists of four major projects: (1) Design for Efficient and Affordable Rotorcraft (DEAR); (2) Select Integrated Low-Noise Technologies (SILNT); (3) Safe All-Weather Flight Operations for Rotorcraft (SAFOR); and (4) Fast-Response Industry Assistance Requests (FRIAR).

Program FY99 Objectives

The objectives of the Rotorcraft R&T Base Program are to:

- *Demonstrate high-quality, low-cost composite manufacturing of critical rotorcraft components using resin transfer molding processing.*
- *Complete flight evaluations of Differential Global Positioning System (DGPS) coupled heliport precision instrument approach guidance and obtain a Terminal Procedures (TERPS) database.*
- *Complete testing of a baseline rotorcraft helical gear train configuration to establish minimum lubrication conditions while maintaining ultrasafe operation.*
- *Develop new analytical tools suitable for implementation in emerging computer architectures.*
- *Validate prediction of main rotor noise as measured during flight tests, by comparison of measured helicopter noise footprints with predictions.*
- *Demonstrate a validated prediction model for pilot situational awareness for selected rotorcraft missions.*
- *Demonstrate an Integrated Helicopter Design Tool set based on Common Object Request Broker Architecture-compliant architecture that will reduce development time and improve quality.*
- *Complete proof-of-concept demonstration of an innovative design for the world's first ultrasafe gear.*
- *Establish control law, inceptor, and display concepts for short take-off / vertical landing through simulation.*

Program Approach

The long-term goals in the rotorcraft program are strongly coupled with both industry and academia through the aeronautics strategic planning process and direct customer interaction. The DEAR, SILNT, and SAFOR projects are structured to address the identified longer-term, higher-risk technology needs. The shorter-term technology development is implemented through a unique government / industry partnership, the National Rotorcraft Technology Center (NRTC). NASA and the Department of Defense (DoD) fund this effort, with matching funds from the rotorcraft industry, to develop technology that ensures the economic competitiveness and continued military supremacy of U.S. rotorcraft. Technology projects, of which an example is the FRIAR project, are selected from an annual research portfolio proposed and cofunded by the industry members, with participation of subtier manufacturers and academia.

AVIATION OPERATIONS SYSTEMS R&T BASE PROGRAM

The Aviation Operations Systems (AOS) Program works to enable major increases in safety of aircraft operations in the National Airspace System (NAS) and worldwide through the development and validation of advanced technology concepts, methodologies, and procedures, and their transfer to the user and regulatory communities. The key components that comprise aviation safety are the aircraft / aviation system, people, and the environment. The AOS Base Program comprises three investment areas to address these components: Systems Design, Assessment, and Reliability (SDAR); Human Performance and Countermeasures (HPC); and Hazardous Environment Prediction and Mitigation (HEPM).

Program FY99 Objectives

The following milestones reflect the specific objectives of the Ames Research Center elements of the AOS Program in FY99:

- *Develop a first-generation, system-wide monitoring capability to measure and communicate the health and status of operational safety performance. (SDAR)*
- *Develop a model of human memory constraints in reactive planning and procedure execution. (SDAR)*

Program Approach

The Systems Design, Assessment, and Reliability (SDAR) research projects address aviation system performance and reliability, including the human operators explicitly, from both assessment and design points of view. The specific emphasis is on design methodologies and validated technologies and procedures for both airborne and ground system automation that properly address integration with the human operators.

The Human Performance and Countermeasures (HPC) research projects will develop knowledge bases and models of fundamental human information processing capabilities. These tools can then be used to develop technologies to enhance human information processing capabilities or to devise countermeasures to remediate them.

The Hazardous Environment Prediction and Mitigation (HEPM) research projects will develop databases, knowledge bases, models, and predictive technologies to assess critical weather influences on both safety and efficiency. Advanced concepts and procedures to identify environmental hazards and to avoid or mitigate their effects will be identified.

Extensive cooperation will be undertaken with the operations community and the Federal Aviation Administration.

Enterprise Goals/ Objectives Served

The primary AT Enterprise goal served by these areas of the AOS Program is:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years.*

The primary AT Enterprise goal served by these areas of the Aviation System Capacity (ASC) Program is:

Pillar One:
Global Civil Aviation

- *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.*

AVIATION SYSTEM CAPACITY PROGRAM

The Aviation System Capacity (ASC) Program strives to enable safe increases in the capacity of major U.S. and international airports through both modernization and improvements in the Air Traffic Management System and the introduction of new vehicle classes that can reduce congestion. Specifically, the goals of the ASC Program are to create advanced concepts, and technologies that will enable new aircraft development; and to implement operational concepts and their associated decision support tools, procedures, and hardware systems to maximize safety, efficiency, and flexibility of operations in the National Airspace System. The ASC Program comprises three major projects that, as an integrated effort, provide a focused technology foundation. These projects are: Advanced Air Transportation Technologies (AATT); Terminal Area Productivity (TAP); and Civil Tiltrotor (CTR).

Program FY99 Objectives

The following milestones reflect the specific objectives of the Ames Research Center elements of the ASC Program for FY99:

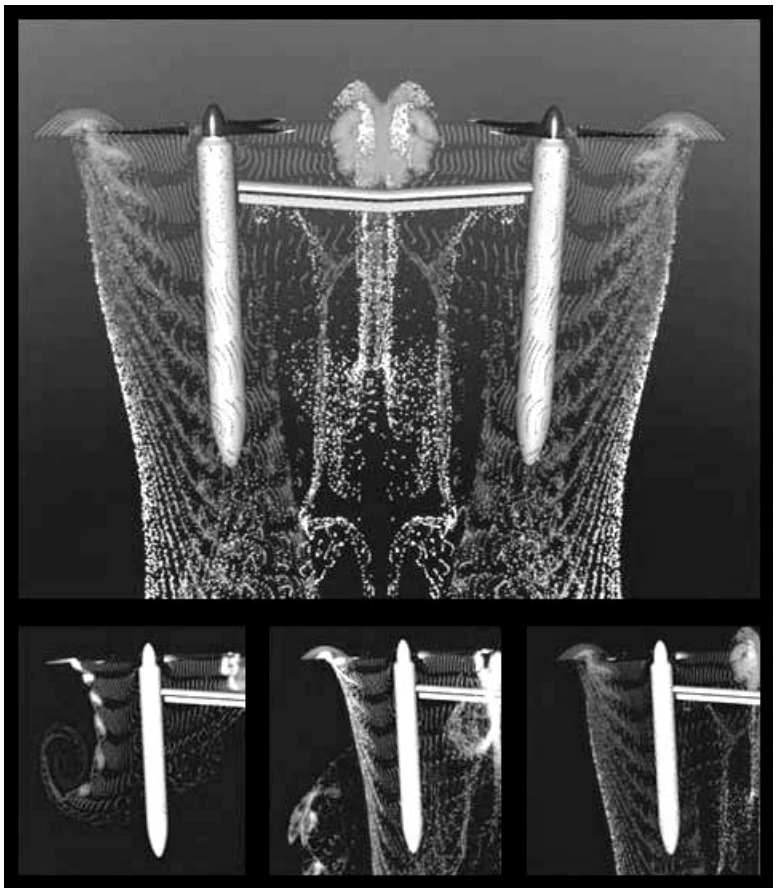
- *Complete the definition of expanded operational evaluation of advanced air transportation technologies for application to the northeast corridor and distributed air / ground traffic separation. (AATT)*
- *Simulate coordinated Aircraft Vortex Spacing Separation (AVOSS), Center terminal radar approach control facilities (TRACON) Automation System (CTAS), and Dynamic Runway Occupancy Measurement (DROM) dynamic spacing. (TAP)*
- *Develop a flight database of low-noise operating procedures. (CTR)*

Program Approach

The goal of the AATT Project is to enable substantial increases in the efficiency and capacity of aircraft operations within both the national and the global air transportation system. The approach is to maximize "free flight" to allow the users to lower direct operating costs by trading off time and routing, and to improve the effectiveness of high-density operations in regions where free flight will not be possible. The program also works to enable operation in a smooth and efficient manner across boundaries of free-flight and capacity-constrained flight regions; provide system improvements that are easily deployable anywhere in the world; and improve the ability to model and simulate advanced capabilities in the airspace system and its subcomponents. The AATT Project manages programmatic and technical integration with a systems engineering effort that includes IV&V support in the areas of software development tracking and evaluation.

The goal of the Terminal Area Productivity (TAP) Project is to increase airport terminal area capacity in nonvisual, or instrument-weather, conditions. The technical approach is to provide technologies and operating procedures that will increase productivity of the airport terminal area in instrument-weather conditions to safely match that of clear-weather, or visual conditions. It is anticipated that integrated ground and airborne technology will safely reduce spacing inefficiencies associated with single runway operations and the required spacing for independent, multiple-runway operations conducted under instrument flight rules by the end of the decade.

The goal of the NASA Civil Tiltrotor Project is to develop the most critical technologies needed to overcome the inhibitors of operating civil tiltrotor aircraft within the air transportation system. These technologies include an efficient, low-noise proprotor; an integrated cockpit for minimum pilot workload during low-noise approaches and departures near congested terminal areas; and safe and cost-effective one-engine-inoperative emergency contingency power capability.



ENTERPRISE GOALS/
OBJECTIVES SERVED

These simulation facilities provide critical support to the following AT Enterprise Pillars and goals:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years.*
- *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.*
- *Reduce the perceived noise levels of future aircraft by a factor of 2 (from today's subsonic aircraft) within 10 years, and by a factor of 4 within 25 years.*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 25 years.*

Pillar Two: Revolutionary Technology Leaps

- *Reduce the travel time to the Far East and Europe by 50 percent within 25 years, and do so at today's subsonic ticket prices.*
- *Provide next-generation design tools and experimental aircraft to increase design confidence, and cut the development cycle time for aircraft in half.*

Pillar Three: Access to Space

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 25 years.*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years.*

SIMULATION FACILITY GROUP DIRECTOR

In May 1995, the AT Enterprise determined that central management of major aeronautical facilities was in the Nation's best interest and established several facility groups. Ames is responsible for management of one of those groups: the Simulation Facility Group (SFG). This group is the single mechanism utilized by the Enterprise for strategic management and integrated activity planning in the areas of facility investment, operations policy, business management, and test technology for designated simulation facilities. The SFG considers a U.S. national perspective that includes not only the military and commercial aerospace interests of the government, but those of industry as well.

Facilities within the purview of SFG are: the Crew Vehicle Simulation Research, Vertical Motion Simulator, and Surface Development and Test Facilities at Ames Research Center; and the Visual Motion Simulator, Differential Maneuvering Simulator, and Cockpit Motion Facilities at Langley Research Center.

Program FY99 Objectives

The group's FY99 objectives can be broken into three areas: planning, test technology, and business management.

Planning

- *Compile near-term and long-term customer requirements.*
- *Develop facility investment strategy and plans, including innovative financing methods for new capability, upgrade of existing capability, and consolidation / closure.*

Test Technology

- *Establish national requirements.*
- *Develop a nationally integrated test technology plan that utilizes both government and industry resources.*

Business Management

- *Facilitate the development and maintenance of a consistent charging policy and cost reporting formats.*
- *Develop common customer interfaces, such as test request information, model design criteria, customer contract / agreement, and customer critique procedures.*

Program Approach

The Simulation Facility Group is led by the SFG Director, with assistance provided by the Simulation Integration Task Team (ITT). The ITT consists of site managers and simulation technology experts located at Ames and Langley. SFG has the responsibility and authority for issue resolution, while the NASA Centers retain facility ownership, funding and operations responsibility, and authority over all matters related to their facilities, with oversight provided by OAT. SFG also recommends and encourages implementation of common processes, products, and procedures where possible.

SPACE TRANSPORTATION TECHNOLOGY

Ames leads the Enterprise core competencies in the areas of thermal protection systems (TPS), advanced information technology systems, and advanced tool and test application.

Program FY99 Objectives

Ames' FY99 objectives for the Space Transportation Technology program are to:

- *Complete supporting work on TPS designs, technologies, and test data and hardware for developing the next generation of Reusable Launch Vehicles (RLV), including the X-33 and X-34. Complete Independent Verification and Validation (IV&V) tasks for X-33 flight software. Support initial flight testing of the X-34 and X-33, as appropriate.*
- *Participate in the new Future X Reusable Space Transportation Program by providing TPS and other technologies. Propose continued flight experimentation of a revolutionary new class of vehicles with sharp leading edges / nose caps (millimeter radii).*
- *Develop and initiate work for the Small Scientific Payloads Program (formally known as Bantam).*
- *Complete the work needed to provide ceramic heat-shield materials to the Stardust program.*
- *Provide the enabling aeroassist and heat-shield technologies for the Mars 2001 mission.*
- *Continue to develop technologies / flight technology validation experiments required for high-speed re-entry of samples returned from the robotic exploration of the solar system.*
- *Continue to support space transportation planning needs for the Integrated Mars Exploration Program jointly led by Johnson Space Center (JSC) and the Jet Propulsion Laboratory (JPL), including crewed missions to Mars.*

Program Approach

Important elements of the work performed in support of the Space Transportation Technology programs are: new TPS materials / systems; rapid design tools for TPS sizing; operation of unique large-scale, high-temperature, arc-jet ground-test facilities; and general support of industry-led teams developing next-generation vehicles. Ames will develop the thermal protection systems necessary for future space vehicles that fly at hypervelocities within the atmospheres of the Earth and other bodies within the solar system. Ames will also develop advanced information technology systems tools, including integrated design system tools (IDS), integrated vehicle health management (IVHM), and independent verification and validation (IV&V). And finally, Ames will advance the application of tools and test capabilities from its aeronautics program to the needs of the space transportation program.

ENTERPRISE GOALS/
OBJECTIVES SERVED

The enterprise goals supported by this work are:

Pillar Three:
Access to Space

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 25 years.*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years.*

The primary Enterprise goals served by the Airframe and Propulsion Systems, and the High-Speed Research and Advanced Subsonic Transport programs are:

Pillar One: Global Civil Aviation

- *Reduce the perceived noise levels of future aircraft by a factor of 2 (from today's subsonic aircraft) within 10 years, and by a factor of 4 within 25 years.*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 25 years.*

Pillar Two: Revolutionary Technology Leaps

- *Reduce the travel time to the Far East and Europe by 50 percent within 25 years, and do so at today's subsonic ticket prices.*
- *Provide next-generation design tools and experimental aircraft to increase design confidence, and cut the development cycle time for aircraft in half.*

AIRFRAME AND PROPULSION SYSTEMS BASE TECHNOLOGY PROGRAMS

Ames performs a variety of tasks to support both the Airframe Systems Base Technology Program led at Langley Research Center and the Propulsion Systems Base Technology Program led at Lewis Research Center. These programs draw upon many of the Ames core competencies, including information technology and critical facilities, to achieve their goals.

Program FY99 Objectives

To support programs in Airframe and Propulsion Systems, Ames is undertaking the following tasks in FY99:

- *Define noise reduction concepts for Futuristic Aircraft.*
- *Develop advanced semispan wind tunnel testing techniques.*
- *Develop Computational Fluid Dynamics (CFD) capability to predict jet noise using large eddy simulation / direct numerical simulation (LES / DNS) approach.*

Approach

To use existing Ames core competencies collaboratively with other NASA Centers to support their program goals and responsibilities.

HIGH-SPEED RESEARCH AND ADVANCED SUBSONIC TRANSPORT FOCUSED TECHNOLOGY PROGRAMS

Ames performs a variety of tasks to support both the High-Speed Research and Advanced Subsonic Transport Focused Technology Programs led at Langley Research Center. These programs draw upon many of the Ames core competencies, including information technology and critical facilities, to achieve their goals.

Program FY99 Objectives

To support programs in High-Speed Research and Advanced Subsonic Transport, Ames is undertaking the following tasks in FY99:

- *Reduce the time required to perform three-dimensional high-lift aerodynamic CFD computations by two orders of magnitude.*
- *Develop and test large-scale semispan wind tunnel models of advanced noise reducing airframe concepts with integrated propulsion systems.*
- *Develop advanced CFD optimization tools and techniques for aerodynamic shapes.*

Approach

Existing Ames core competencies will be used collaboratively with other NASA Centers to support their program goals and responsibilities.

Space Science Enterprise

The mission of the Space Science Enterprise, as described in The Space Science Enterprise Strategic Plan (Nov. 1997), is to solve mysteries of the universe, explore the solar system, discover planets around other stars, and search for life beyond Earth.

Detailed space science planning begins with a set of fundamental questions or pillars. These questions form the basis for our scientific program over the next several decades. They are:

- *How did the universe begin and what is its ultimate fate?*
- *How do galaxies, stars, and planetary systems form and evolve?*
- *What physical processes occur in extreme environments (black holes)?*
- *How and where did life begin?*
- *How is the evolution of life linked to cosmic phenomena?*
- *Why does the sun vary and how do the Earth and other planets respond?*
- *How might humans inhabit other worlds?*

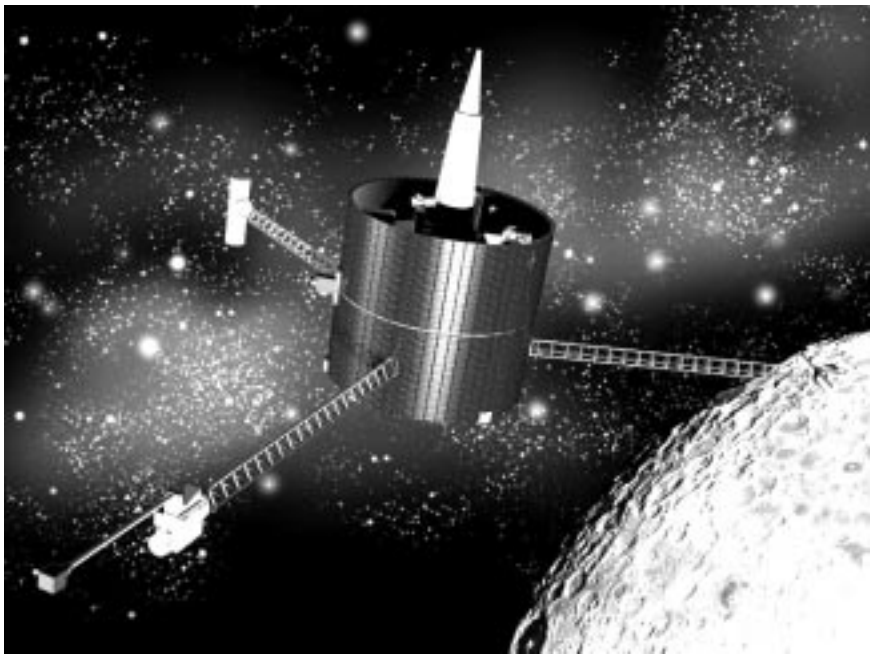
To address these fundamental questions, the Space Science Enterprise, in conjunction with the space science community, has laid out a series of Enterprise Goals to guide our activities. These include:

- *Establish a virtual presence throughout the solar system, and probe deeper into the mysteries of the universe and life on Earth and beyond.*
- *Pursue space science programs that enable and are enabled by future human exploration beyond low Earth orbit.*
- *Develop revolutionary technologies for missions.*
- *Contribute to achieving science, mathematics, and technology education goals and share the excitement and inspiration of our discoveries.*

These goals have been further refined into 11 Science Goals:

- Goal 1: *Understand how structure in our universe (e.g., clusters of galaxies) emerged from the Big Bang.*
- Goal 2: *Test physical theories and reveal new phenomena throughout the universe, especially through the investigation of extreme environments.*
- Goal 3: *Understand how both dark and luminous matter determine the geometry and fate of the universe.*
- Goal 4: *Understand the dynamical and chemical evolution of galaxies and stars and the exchange of matter and energy among stars and the interstellar medium.*
- Goal 5: *Understand how stars and planetary systems form together.*
- Goal 6: *Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.*

- Goal 7: *Understand mechanisms of long- and short-term solar variability, and the specific processes by which Earth and other planets respond.*
- Goal 8: *Understand the origin and evolution of life on Earth.*
- Goal 9: *Understand the external forces, including comet and asteroid impact, that affect life and the habitability of Earth.*
- Goal 10: *Identify locales and resources for future human habitation within the solar system.*
- Goal 11: *Understand how life may originate and persist beyond Earth.*



Ames' Role in Support of the Space Science Enterprise

Ames supports the Space Science objectives through fundamental research in astrobiology, exobiology, origins, astrophysics, and planetary science, as well as through technology and flight project development and operations. The chief elements supporting Space Science are: Space Science Research; the Stratospheric Observatory for Infrared Astronomy Program; and other elements, including the Center for Mars Exploration and the Lunar Prospector Project.

SPACE SCIENCE RESEARCH

Space Science Research at Ames implements the Space Science Enterprise Goals through three elements, dealing with Astrophysics, Planetary Systems, and Exobiology. **Astrophysics** research addresses Enterprise goals and objectives that deal with understanding how the structure in our universe emerged, the dynamical evolution of galaxies and stars, and the exchange of matter and energy among stars and the interstellar medium. **Planetary Systems** research addresses Enterprise goals and objectives that deal with understanding star formation, the evolution and distribution of volatile and organic material, the origin and distribution of planetary systems, rings, and primitive bodies, and planetary atmosphere evolution. **Exobiology** research addresses Enterprise goals and objectives that deal with understanding the origin, evolution, and distribution of life by conducting research on the cosmic history of biogenic compounds, prebiotic evolution, and the early evolution of life.

FY99 Objectives

The following FY99 objectives are representative of a more comprehensive approach represented by some 125 separate research tasks.

- *Conduct monthly meetings and a summer workshop under the auspices of the Center for Star Formation.*
- *Develop alternative mechanisms to ultraviolet (UV) photolysis for the production of aliphatic hydrocarbon bands seen in the interstellar medium.*
- *Use Hubble Space Telescope (HST) observations of Saturn's rings to confirm ring-spoke particle sizes of 0.5–0.6 micrometers.*
- *Publish models of planetary growth that will help explain observations of extrasolar planets.*
- *Compute the Martian annual water cycle at different orbital configurations and compare with observations.*
- *Determine if methane can explain the runaway greenhouse effect early in Titan's history.*
- *Identify the mechanism of synthesis of prebiotically relevant organic acid compounds in the Murchison meteorite.*
- *Develop models for transmembrane proton transfer utilizing specialized peptide-based transfer molecules.*
- *Demonstrate that alkanes are biomarkers that can be used to identify the presence of cyanobacteria in microbial mats from thermal springs.*
- *Use new orbital calculations of near-Earth asteroids to refine estimates of the rate of impact of 1–10 km objects on Earth.*
- *Use carbon isotope signatures in sedimentary kerogens and carbonates to determine if the oxidation state of the global environment increased between 2.3 and 1.8 billion years ago.*
- *Analyze organics and minerals in the Mars meteorite to determine whether or not they are biogenic in origin.*
- *Use Mars analog soils to determine the extent of loss of biological information in samples sterilized by irradiation.*
- *Use previous work on ice-covered lakes in Antarctica to develop planetary protection guidelines for missions to Europa.*

ENTERPRISE GOALS/ OBJECTIVES SERVED

Of the 11 Science Goals identified in the Space Science Enterprise Strategic Plan, Space Science Research at Ames makes a significant contribution to the six that follow:

Goal 4: *Understand the dynamical and chemical evolution of galaxies and stars and the exchange of matter and energy among stars and the interstellar medium.*

Goal 5: *Understand how stars and planetary systems form together.*

Goal 6: *Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.*

Goal 8: *Understand the origin and evolution of life on Earth.*

Goal 9: *Understand the external forces, including comet and asteroid impact, that affect life and the habitability of Earth.*

Goal 11: *Understand how life may originate and persist beyond Earth.*

Goal 4: *Understand the dynamical and chemical evolution of galaxies and stars and the exchange of matter and energy among stars and the interstellar medium.*

Goal 5: *Understand how stars and planetary systems form together.*

Goal 6: *Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.*

Goal 8: *Understand the origin and evolution of life on Earth.*

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY PROGRAM

The Stratospheric Observatory for Infrared Astronomy (SOFIA), a key element of NASA's new Origins program, is a large-aperture infrared/submillimeter observatory being developed cooperatively by NASA and the Deutsche Forschungsanstalt für Luft-und Raumfahrt (DLR) in Germany. SOFIA will operate in the stratosphere, above 99 percent of the water vapor that obscures infrared wavelengths from all ground-based observatories. The SOFIA System includes the observatory—a 2.5-meter-aperture telescope mounted in an open-port cavity in a 747 aircraft—plus a science and mission operations center located at Ames Research Center. Across most of the infrared spectral region, SOFIA will have the highest broadband imaging and spectroscopic resolution of any observatory currently approved for development, and will also be deployable worldwide to observe transient events such as occultations and supernovae.

Program FY99 Objectives

- *For the German-provided telescope, to successfully complete a Critical Design Review so that full-scale production of the telescope may begin.*
- *For the U.S. Systems, to complete the Preliminary Design Review of the SOFIA System so that detailed design of the aircraft modification, onboard mission control system, and science and mission operations center may be initiated.*

Program Approach

The observatory is optimized for studying far-infrared wavelengths between 30 and 300 micrometers; however, science data will be obtained across the broad wavelength range of 0.3 to 1600 micrometers through the use of numerous focal plane instruments brought to the observatory by the international science community. The ability to regularly upgrade instruments will enable the observatory to employ the very latest focal plane and other instrument technologies, including large-format infrared (IR) and submillimeter detector arrays, which will be transferable to other missions over SOFIA's 20-year operating lifetime.

The SOFIA System is under development by contractor teams in the U.S. and Germany. The U.S. team, led by the Universities Space Research Association (USRA), is developing the 747 modification, including the large cavity cutout, rerouting of the airframe structure around the cutout, rerouting of the aircraft systems through the telescope cavity, and developing the new systems installations such as the cavity door and environmental control system. USRA's team is also providing the onboard mission control system, and the science and mission operations center. Several of these items are being developed in conjunction with NASA Ames, which is providing some of the designs, hardware, and facilities. In Germany, a consortium of companies led by MAN Technology is developing the airborne telescope assembly, including its 2.7-meter-diameter primary mirror, and its optics, structure, isolation, and pointing control systems. The telescope will be delivered to the U.S. in early 2001 for installation into the modified 747, followed by a planned series of test flights. Science operations will start about a year later.

OTHER SPACE SCIENCE ELEMENTS

Additional research areas at Ames play major roles in the implementation of the Space Science Goals. One area is the **Center for Mars Exploration** (CMEX), a joint activity of the Space and Information Systems Directorates, which deals with goals and objectives for integrated human and robotic Mars exploration. A second area, **Space Projects**, addresses Enterprise goals and objectives that deal with advanced technology and advanced mission concepts for solar system exploration missions and projects. The third unit is **Space Technology**, which addresses Enterprise goals and objectives that deal with development of advanced technologies to enable future robotic and human solar system exploration missions. The final unit is the **Lunar Prospector Project**, which is currently in the midst of its primary mission in orbit around the Moon. Data gathered by the Lunar Prospector spacecraft will complete the most comprehensive data set available for any extraterrestrial planetary body. It will also allow better usage of the Moon, as a model to study other worlds and as a potential platform for studying further human exploration of space.

FY99 Objectives

- *Complete the acquisition of lunar data from the nominal mission of Lunar Prospector.*
- *Fabricate IR detectors and test under the conditions expected at the NGST focal plane.*
- *Continue development of the AIRES facility science instrument for SOFIA.*
- *Guide the integrated human and robotic Mars Exploration Program in its science-based exploration strategy in the search for past and present life on Mars, particularly in characterizing landing sites and evaluating landing site data.*
- *Develop the policies and procedures for forward and backward planetary protection to ensure that: human crews may safely explore Mars; samples may be brought back to Earth from Mars without damaging the terrestrial biosphere; and life-detection experiments are not invalidated by contamination from terrestrial organisms.*
- *Evaluate the application of controlled airborne platforms for the acquisition of high-resolution and high-sensitivity remote sensing data for the selection of potential landing sites.*
- *Maintain a state-of-the art global circulation model of the martian atmosphere and provide detailed interpretation of this model to spacecraft engineers concerned with atmospheric entry and landing issues and with the effects of wind-blown dust on the performance of landed spacecraft and crew.*
- *Explore various concepts to collect samples from the kilometers-deep martian hydrosphere.*
- *Produce preliminary designs of concepts for controlled airborne platforms to acquire high-resolution data about landing sites on Mars.*
- *Conduct a workshop to explore Planetary Protection issues for human missions to Mars.*

ENTERPRISE GOALS/ OBJECTIVES SERVED

The primary Space Science Enterprise goals served by these elements are:

Goal 4: *Understand the dynamical and chemical evolution of galaxies and stars and the exchange of matter and energy among stars and the interstellar medium.*

Goal 5: *Understand how stars and planetary systems form together.*

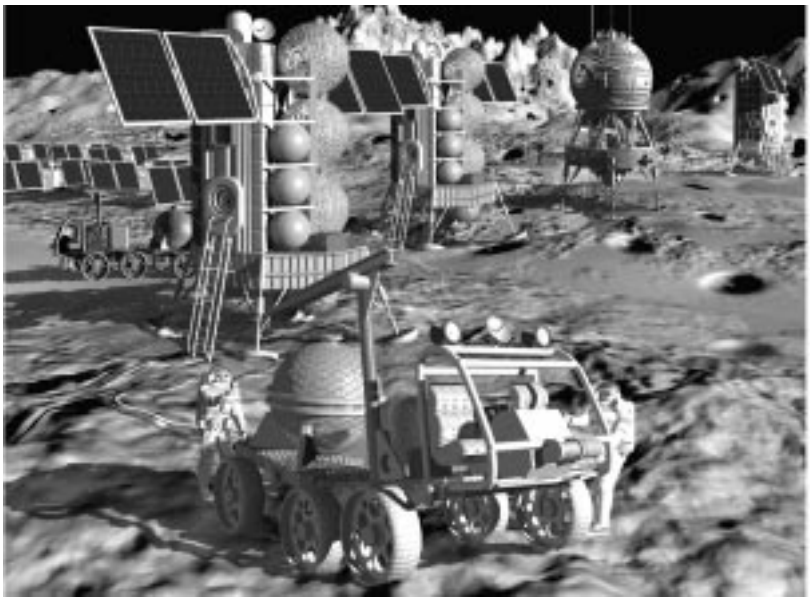
Goal 6: *Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.*

Goal 10: *Identify locales and resources for future human habitation within the solar system.*

Human Exploration and Development of Space (HEDS) Enterprise

The mission of the Human Exploration and Development of Space (HEDS) Enterprise is to open the space frontier by exploring, using, and enabling the development of space, and to expand the human experience into the far reaches of space. The goals and objectives of the HEDS Enterprise are:

- Goal 1: Increase human knowledge of nature's processes using the space environment.
  - *Objective 1: Understand the fundamental role of gravity and the space environment in biological, chemical, and physical systems.*
  - *Objective 2: Use HEDS' research facilities innovatively to achieve breakthroughs in science and technology.*
- Goal 2: Explore and settle the solar system.
  - *Objective 1: Enable human exploration through Space Science Enterprise Robotic Missions.*
  - *Objective 2: Expand human presence in space by assembling and operating the International Space Station.*
  - *Objective 3: Develop biomedical knowledge and technologies to maintain human health and performance in space.*
  - *Objective 4: Establish a human presence on the Moon, in the martian system, and elsewhere in the inner solar system.*
  - *Objective 5: Develop opportunities for commerce in space as a basis for future settlements.*
- Goal 3: Achieve routine space travel.
  - *Objective 1: Sustain Space Shuttle operations at improved levels of safety and efficiency.*
  - *Objective 2: Ensure the health, safety, and performance of space flight crews through space and environmental medicine.*
  - *Objective 3: Develop requirements and demonstrate and implement advanced propulsion systems and other advanced space transportation systems and capabilities to enable exploration.*
- Goal 4: Enrich life on Earth through people living and working in space.
  - *Objective 1: Promote knowledge and technologies that promise to enhance our health and quality of life.*
  - *Objective 2: Broaden and strengthen our Nation's achievements in science, math, and engineering.*
  - *Objective 3: Involve our Nation's citizens in the adventure of exploring Space.*
  - *Objective 4: Join with other nations in the international exploration and settlement of space.*



Ames' Role in Support of the HEDS Enterprise

Ames supports the HEDS guidelines through fundamental research in astrobiology, gravitational biology and ecology, evolutionary biology, advanced technology development, and advanced concepts for lunar and Mars exploration. The chief elements supporting HEDS are:

- *The Gravitational Biology & Ecology (GB&E) Program*
- *Life Science Research*
- *The Space Station Biological Research Project (SSBRP)*

GRAVITATIONAL BIOLOGY & ECOLOGY (GB&E) PROGRAM

Management of the HEDS Program in Gravitational Biology & Ecology has been assigned to Ames Research Center by the NASA Office of Life Sciences. Also associated with this program is an Agency-wide responsibility for life science education and public outreach.

FY99 Objectives

- *Publish at least 90 percent of the research data sponsored by the GB&E Program and make it accessible on the Internet.*
- *Increase research principal investigators (PIs) in the GB&E Program to contribute to the 9 percent projected increase for OLMSA.*
- *Select and award proposals emphasizing biology-inspired technologies.*
- *Establish an integrated NASA-wide program in evolutionary biology led by a National Center for Evolutionary Biology with participation of at least 5 research institutions and engaging 20 investigators.*
- *Analyze data from Mir to achieve a one-crew-year "jump start" for International Space Station (ISS) fundamental biology.*
- *Issue Life Sciences NASA research announcement (NRA), including Gravitational Biology & Ecology.*
- *Utilize the Internet and advanced communication tools to assure that archived flight and ground data reach the scientific, educational, and public arenas.*
- *Create and support educational programs and resources using HEDS Enterprise content:*
  - Develop and distribute curriculum enhancements, in partnership with leading educational institutions.
  - Provide experiential learning activities directly related to real-time space adventures to classrooms K–14.
  - Partner with science and technology museums and teacher training colleges to advance teacher competency.
  - Leverage expertise and partnerships with the Native American community.
- *Create virtual tours, virtual experimental environments, and public displays to provide participatory experiences in space focused on human exploration and the advance of human potential:*
  - Develop space analog environments and mission simulations in partnerships with museum and "edutainment" facilities.
  - Outfit and operate the "ground-based" Spacelab for public audiences.
  - Target opportunities for direct educational and informational use of HEDS flight projects.
  - Develop simultaneous ground and flight real-time experiences for public audiences.

ENTERPRISE GOALS/ OBJECTIVES SERVED

The primary HEDS Enterprise goals and objectives served by the GB&E program are:

Goal 1: *Increase human knowledge of nature's processes using the space environment.*

– ***Objective 1:*** *Understand the fundamental role of gravity and the space environment in biological, chemical, and physical systems.*

– ***Objective 2:*** *Use HEDS' research facilities innovatively to achieve breakthroughs in science and technology.*

Goal 4: *Enrich life on Earth through people living and working in space.*

– ***Objective 2:*** *Broaden and strengthen our Nation's achievements in science, math, and engineering.*

– ***Objective 3:*** *Involve our Nation's citizens in the adventure of exploring space.*

Program Approach

The approach of the GB&E Program is to:

- *Effectively use microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes.*
- *Develop the scientific and technical foundations for a safe, productive human presence in space for extended periods and in preparation for exploration.*
- *Apply this knowledge and technology to improve the Nation's competitiveness, education, and the quality of life on Earth.*
- *Inform, educate, and provide opportunities for students and the public to participate in life science research, which uses the unique laboratory of space to understand fundamental biology, physiology, evolution, and development of living systems.*

LIFE SCIENCE RESEARCH

The goal of Life Sciences Research at Ames is to understand the role and influence of gravity on living systems, from cells in culture to physiological studies in animals and humans. Through a better understanding of fundamental biology will come knowledge useful for both the development of countermeasures to the deleterious effects of weightlessness and the maintenance of human health on Earth.

FY99 Objectives

- *Complete data analysis and publish results from the Space Shuttle Neurolab mission (STS-90).*
  - Compare responses of at least three different biological models to understand the influence of gravity on the normal development of the nervous system.
  - Define the course of adaptations in the balance system developed over time in response to altered gravitational environments.
- *Fly gravitational biology experiments on STS-95, STS-93, and STS-96.*
- *Initiate the Hyper-g Project to provide baseline data on the effects of altered gravity on biological systems.*
- *Initiate new research in astrobiology and evolutionary biology.*
- *Advocate to principal investigators the use of the unique suite of ground-based research acceleration facilities at ARC.*
- *Complete Mars Surveyor 2001 technology tests.*
- *Support the Johnson Space Center (JSC) in the design and evaluation of a short-arm centrifuge for potential use as a countermeasure to biomedical problems associated with long-term spaceflight.*
- *Complete human bedrest study to determine the efficacy of lower-body negative pressure and exercise as a potential countermeasure for flight biomedical problems.*
- *Apply ARC three-dimensional (3-D) imaging and communication technologies to facilitate the transfer and analysis of medical information, jointly with Stanford University and Salinas Valley Medical Center.*
- *Support NASA Headquarters in the organization and conduct of international workshops and working groups to facilitate the collaborative development and use of flight equipment and flight opportunities, as well as the exchange of scientific information.*

Approach

The approach of Life Science Research at Ames is to:

- *Conduct extensive ground-based studies utilizing a suite of unique gravitational research facilities and advanced 3-D imagery technologies.*
- *Implement programs for the Space Shuttle, the International Space Station, and a variety of automated orbiting vehicles.*
- *Develop the technology and flight equipment required to support NASA's Life Sciences research on the ground and in space.*
- *Transfer technology and promote education for the improvement of the quality of life on Earth.*

Enterprise Goals/ Objectives Served

The primary HEDS Enterprise goals and objectives served by Life Science Research are:

Goal 1: *Increase human knowledge of nature's processes using the space environment.*

– ***Objective 1:*** *Understand the fundamental role of gravity and the space environment in biological, chemical, and physical systems.*

– ***Objective 2:*** *Use HEDS research facilities innovatively to achieve breakthroughs in science and technology.*

Goal 2: *Explore and settle the solar system.*

– ***Objective 1:*** *Enable Human Exploration through space science enterprise robotic missions.*

– ***Objective 3:*** *Develop biomedical knowledge and technologies to maintain human health and performance in space.*

Goal 4: *Enrich life on Earth through people living and working in space.*

– ***Objective 1:*** *Promote knowledge and technologies that promise to enhance our health and quality of life.*

– ***Objective 4:*** *Join with other nations in the international exploration and settlement of space.*

The primary HEDS Enterprise goal and objectives served by the SSBRP are:

Goal 1: *Increase human knowledge of nature's processes using the space environment.*

– ***Objective 1:*** *Understand the fundamental role of gravity and the space environment in biological, chemical, and physical systems.*

– ***Objective 2:*** *Use HEDS's research facilities innovatively to achieve breakthroughs in science and technology.*

SPACE STATION BIOLOGICAL RESEARCH PROJECT (SSBRP)

The Space Station Biological Research Project (SSBRP) supports Life Sciences Research goals by enabling long-term space science research in all the life sciences disciplines. The research program will initially emphasize microbiology and cell culture research using Incubator (INC) and Cell Culture Unit (CCU) habitats supported in a Habitat Holding Rack (HHR). Later, research capability will be augmented by a second HHR, a Life Sciences Glovebox (LSG), variable-g centrifuge, and habitats for plants, insects, rodents, aquatic organisms, and avian and reptilian eggs.

Project FY99 Objectives

- *Complete contracts with hardware developers and International Partners for Habitats and Host systems, including the Habitat Holding Rack, Centrifuge, and Life Sciences Glovebox.*
- *Complete designs and begin fabrication of UF-3 flight hardware, including Cell Culture Unit, Incubator, Insect Habitat, Glovebox, and Habitat Holding Rack 7.*
- *Deliver for launch and validate a suite of biological habitats and equipment to support gravitational biology research in space.*

Project Approach

The Project is responsible for design, development, test, verification, and on-orbit validation of the flight hardware and software. SSBRP is also responsible for the development of interactive ground communication facilities with Space Station, other NASA Centers, and PIs in their laboratories. SSBRP will also develop common-use Space Station laboratory support equipment such as a Small Mass Measurement Device (SMMD), a Micro Mass Measurement Device (MMMD), compound and dissecting microscopes, and radiation dosimeters. Partners in the hardware development include the National Aerospace Development Agency of Japan (NASDA), Canadian Space Agency (CSA), Hungarian Space Office (HSO), and six small and large business enterprises.

OTHER HEDS RESEARCH

Additional research elements at Ames play major roles in the implementation of the HEDS Enterprise Goals. The Center for Mars Exploration (CMEX) supports integrated human and robotic Mars exploration research. Advanced Life Support (ALS) research develops systems that provide the foundation for long-duration missions by significantly reducing life-cycle costs, improving operational performance, promoting self-sufficiency, and increasing safety, as well as providing commercial opportunities for public benefit. The Advanced Technology Development Biosensors (ATD-B) Program facilitates the flow of advanced sensor and measurement technologies within and between NASA and other organizations.

FY99 Objectives

- *Guide the integrated human and robotic Mars Exploration Program in its science-based exploration strategy in the search for past and present life on Mars, particularly in characterizing landing sites and evaluating landing site data.*
- *Develop the policies and procedures for forward and backward planetary protection to ensure that samples may be brought back to Earth from Mars without damaging the terrestrial biosphere.*
- *Assess the technology needed to gain access to, and aseptically collect samples from, the kilometers-deep martian hydrosphere.*
- *Evaluate the application of controlled airborne platforms for the acquisition of high-resolution and high-sensitivity remote sensing data for the selection of potential landing sites.*
- *Build a neural-net simulator facility for testing Mars aerovehicle designs (airplanes, rotorcraft, balloon concepts).*
- *Develop liquefier technology to support ISRU (In Situ Resource Utilization) demonstration on Mars 2003 mission.*
- *Develop and demonstrate information technologies (both software and hardware) to reduce the cost of and increase the performance of human and robotic spaceflight, including autonomous ground and flight systems, enhanced crew operations, intelligent synthesis environment, and data management / analysis.*
- *Develop new thermal protection materials, new aeroassist techniques for the braking of spacecraft in the atmosphere of Mars and on high-speed return in the atmosphere of Earth, and new technologies for the production and cryostorage of propellants and life-support gases and liquids on the surface of Mars.*
- *Work with industry, Lewis Research Center (LeRC), and Marshall Space Flight Center (MSFC) to develop integrated onboard vehicle health management systems to improve vehicle reliability and reduce the ground turnaround of reusable launch vehicles.*

ENTERPRISE GOALS/ OBJECTIVES SERVED

The primary HEDS Enterprise goals and objectives served by this research are:

***Goal 1:** Increase human knowledge of nature's processes using the space environment.*

- ***Objective 1:** Understand the fundamental role of gravity and the space environment in biological, chemical, and physical systems.*

***Goal 2:** Explore and settle the solar system.*

- ***Objective 1:** Enable human exploration through space science enterprise robotic missions.*
- ***Objective 2:** Expand human presence in space by assembling and operating the International Space Station.*
- ***Objective 3:** Develop biomedical knowledge and technologies to maintain human health and performance in space.*
- ***Objective 4:** Establish a human presence on the Moon, in the martian system, and elsewhere in the inner soloar system.*

***Goal 3:** Achieve routine space travel*

- ***Objective 1:** Sustain Space Shuttle operations at improved levels of safety and efficiency.*
- ***Objective 3:** Develop requirements and demonstrate and implement advanced propulsion systems and other advanced space transportation systems and capabilities to enable exploration. (cont.)*

***Goal 4:** Enrich life on Earth through people living and working in space.*

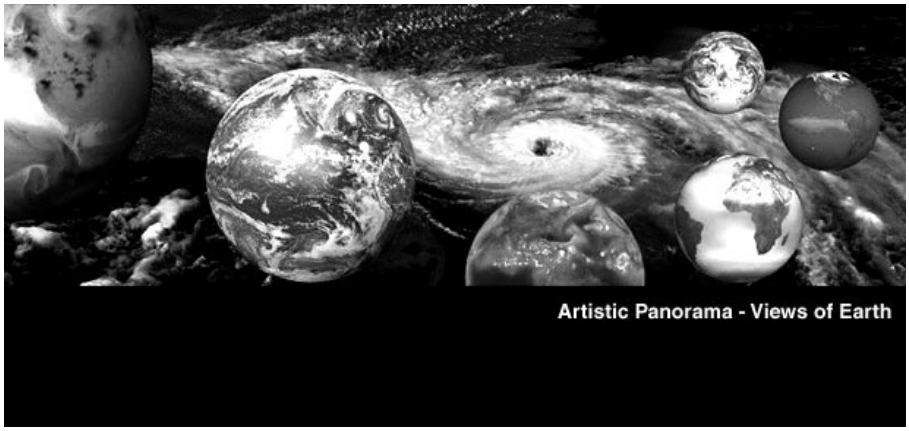
- ***Objective 1:** Promote knowledge and technologies that promise to enhance our health and quality of life.*
- ***Objective 3:** Involve our Nation's citizens in the adventure of exploring space.*

- *Develop automation for life-support system operations, power-generation operations, and in situ propellant-production operations.*
- *Through use of the Internet, increase the participation of the public, educators, and students in the process of planning and implementing the integrated Mars exploration program.*
- *Advance the application of remote sensing and geographic information systems (GISs) to landscape epidemiology and facilitate the transfer of these technologies to the domestic public health community, and internationally through the Center for Health Applications or Aerospace-Related Technologies (CHAART).*

Earth Science Enterprise

The Earth Science Enterprise endeavors to understand the total Earth system and the effects of natural and human-induced changes on the global environment. The Earth Science Enterprise is responsible for creating and maintaining an integrated scientific observation system for the multidisciplinary study of Earth's critical, life-enabling, interrelated processes involving the atmosphere, oceans, land surfaces, and polar regions. The Enterprise is directed toward acquiring scientific knowledge relevant to formulating and implementing environmental policy, both nationally and internationally. The Enterprise goals are:

- Goal 1: *Expand scientific knowledge of the Earth system using NASA's unique capabilities from the vantage points of space, aircraft, and in situ platforms.*
- Goal 2: *Disseminate information about the Earth system.*
- Goal 3: *Enable the productive use of Office of Earth Science (OES) science and technology.*



Artistic Panorama - Views of Earth

Ames' Role in Support of the Earth Science Enterprise

Ames supports the Earth Science goals through fundamental research in astrobiology, ecology, and atmospheric science, as well as through instrument development and science management for NASA airborne platforms.

All three Earth Science Enterprise goals are served by Earth Science Research at Ames:

Goal 1: *Expand scientific knowledge of the Earth system using NASA's unique capabilities from the vantage points of space, aircraft, and in situ platforms.*

Goal 2: *Disseminate information about the Earth system.*

Goal 3: *Enable the productive use of OES science and technology.*

EARTH SCIENCE RESEARCH

Earth Science Research at Ames supports the goals and objectives of the Enterprise described in the *Earth Science Enterprise Strategic Plan of 1998* and the *OES Science Research Plan of 1996*. Ames performs basic research in atmospheric chemistry and dynamics, atmospheric physics, and ecosystem science and technology, and leads major airborne science to provide new knowledge on both atmospheric and ecosystem processes.

FY99 Objectives

- *Manage both the Tropical Rainfall Measuring System (TRMM) and the Correction and Moisture Experiment (CAMEX) airborne science missions and deliver data sets required to fulfill the mission objectives.*
- *Conduct ecosystem process, disturbance, remote sensing, and modeling studies in South America as part of the Large-Scale Biosphere Atmosphere (LBA) project and the Astrobiology program, and in other sites.*
- *Advance the optical science, radiative transport modeling and sensor instrumentation (MASTER, DASI, digital cameras, TIR, and polarization imagers) in support of Earth Observing System (EOS) and airborne science.*
- *Coordinate publication of first Tropospheric Aerosol Radiative Forcing Observational Equipment (TARFOX) special section of JG, submit papers to the ACE-2 special section of Tellus, and coordinate publication of the first Subsonic Assessment Ozone Nitrogen (SONEX) special section in GRL/JGR in early 1999.*
- *Coordinate with several research groups to publish findings from the First International Cloud Climatology Regional Experiment (FIRE) Arctic Cloud Experiment and the Surface Head Budget of the Arctic Ocean (SHEBA), with the goal of providing the most detailed study to date on the Arctic atmosphere/ice surface radiative energy budget.*
- *Acquire and rapidly distribute airborne remote sensing data from a suite of sensors in conjunction with Dryden Flight Research Center (DFRC) and others to science and practical end users in support of the first EOS system and for advanced sensor systems.*
- *Coordinate the publication of the series of interagency studies of fire effects in Brazil and other sites worldwide.*
- *Transfer knowledge and technology to the public sector through education and direct applications research projects such as the Western Region Earth Science Application Center (WRESAC).*
- *Transfer of landscape epidemiology to the worldwide public health community through the activities of CHAART.*
- *Develop means to address large scale computing challenges associated with climate modeling, including parallel computing, utilization of computational grids, and the efficient porting of legacy codes onto advanced architectures.*

- *Work with Earth Science Mission Centers to improve mission software development and validation.*
- *Apply the computer science expertise and large scale system experience of Ames and its partners to help identify the most suitable architectures for the generations of Earth Observing System information systems beyond EOSDIS.*

Approach

Global and regional atmospheric and ecosystem studies are primary areas of investigation at Ames. To carry out these astrobiology-related investigations, scientists, technologists, and mission personnel at Ames work in collaboration with leading scientists and ministries around the world to:

- *Design, formulate, and perform experimental measurements, remote sensing, in situ data analyses, and computer simulations of atmospheric and ecosystem processes, and exchanges between the biosphere and the atmosphere, using both airborne and satellite sensor data.*
- *Conceive and develop advanced instrumentation to satisfy the measurement requirements of the Earth Science Enterprise and related enterprises, emphasizing both airborne and selected spacecraft sensors.*
- *Provide the scientific understanding and the methodology needed to apply remote sensing and geographic data analyses to the study of infectious diseases, and the associated models for risk analysis of disease transmission in the various human populations.*
- *Transfer scientific knowledge and technology to U.S. commercial and private interests, national and international governmental agencies and ministries, other disciplines, and educational institutions.*
- *Provide science mission management and science leadership for major NASA science programs and other agency science programs.*

V. IMPLEMENTING CENTER-LEVEL RESPONSIBILITIES

Initiatives

Safety

In FY99, the Center will be implementing the Safety Accountability Program to reduce the number of hazards on the job and significantly improve safety. The Safety Accountability Program is based on programs in private industry that have proven effective. The new initiative includes the following key elements:

- *Clear and specific safety policy*
- *Executive Safety Committee chaired by the Center Deputy Director*
- *Re-emphasis on system safety*
- *Safety Accountability Program Core*
- *Safety training for all employees*
- *Annual Safety Week*
- *Hotline*
- *Union Management Safety Committee*

All elements are integrated into a single management plan that is designed to change behavior and improve accessibility to management. The complete integration includes a new management culture shift to accountability, combined with metrics, pay for performance, and real-time feedback to management via automation.

ISO 9001

Ames demands world-class leadership in the effective management of its programs and the work it performs. As part of this effort, Ames is focusing its energies in FY99 on becoming ISO 9001 certified. By doing so, Ames will demonstrate that it has a Quality Management System in place that meets a worldwide standard. The implementation of an ISO 9001 quality system will clarify responsibilities and interfaces within Ames, minimize knowledge loss due to turnover, improve first-time conformance to requirements, and increase customer satisfaction. Many of the Center's industrial partners are already ISO certified. Moreover, ISO certification has become a requirement in the Center's significant new procurements.

Ames' goal is to become ISO certified by April 1999, six months earlier than the deadline mandated by the Administrator. Already, the wind tunnel and simulator operations have been recommended for certification. The IV&V Facility is preparing for its certification audit in October 1998. The centerwide responsibility for maintaining ISO certification will reside in the Office of Safety, Environment, and Mission Assurance. Surveillance audits will be performed every six months, and a full quality system audit will be performed every three years.

Full Cost Accounting

Ames is continually striving to improve financial management and increase the efficiency in which financial resources are used. As part of this effort, the Center has been and will continue to be actively involved in the development and execution of full cost accounting. Ames FY00 Full Cost budget will be formulated in POP98-2, and the Ames Resource Management Office anticipates being able to recast the budget submitted in POP98-1 into the full cost structure. This should be possible because of the significant effort expended to formulate the G&A, service pool costs, and rates for distribution to the programs. This recast will build the baseline for dissemination of full cost guidelines for FY01.

Education

As stated in the NASA Strategic Plan, one of NASA's roles is to inspire achievement and innovation. In order to accomplish this, Ames fosters partnerships with teachers and students. The education function at Ames is strategically dispersed throughout the Directorates; in fact, all major technical endeavors at Ames contain educational outreach components. This scenario has increased the magnitude, diversity, and technical excellence of Ames' education programs. The wide range of Ames' education programs are constantly being refined, and new programs are being introduced to better serve the needs of the educational community within the Bay Area, the State of California, and ten other Western states. The following is a brief description of the wide range of educational activities at Ames.

- *The California Air and Space Center (CASC), as defined in partnership with the Mountain View and Sunnyvale City governments, will be a world-class learning facility and will include a teacher institute focused on educating teachers and the public about our country's accomplishments in the air and space arenas.*
- *The onsite Educator Resource Center (ERC) along with 13 regional ERCs in the Western United States provide educators with instructional materials suitable for use in the classroom.*
- *Numerous teacher workshops and conferences are held throughout the region to educate teachers about NASA's programs so they are better able to teach their students.*
- *Ames participates in the annual JASON Project, a live exploration adventure, and trains hundreds of teachers and thousands of students in various science and technology subjects.*
- *The Ames Aerospace Encounter daily hosts fourth- through sixth-grade classes in an interactive, hands-on learning environment designed to teach the basics of science, mathematics, and technology in the thematic areas of aeronautics, Earth science, space science, and space technology.*
- *Center staff participate in National Engineers' week, science and engineering fairs, and an active speakers' bureau.*

- New multimedia education products are produced in conjunction with the significant aeronautics and space programs in the Center. In FY99, the Air Traffic Management CD-ROM and the Lunar Outpost CD-ROM will be produced.

Diversity

Everyone working at the Ames Research Center is valued and no one is excluded on the basis of race, sex, ethnicity, sexual orientation, color, religion, age, disability, or any other nonmerit-based factor. The Center fosters and maintains a work environment that respects and values individual differences and is reflective of the entire range of communities that the Center serves. The Center's efforts are described in the Affirmative Employment Program Plan, updated each fiscal year, and include the following programs:

- *Recruiting—Ames will continue to recruit in order to maintain an applicant pool that includes a high representation of minorities, women, and disabled persons.*
- *Training—Training programs will continue to be used to heighten the awareness of Center managers and employees to the importance of diversity and acceptance of people from diverse backgrounds.*
- *Pipeline development—A variety of outreach activities aimed at primary, secondary, undergraduate, and graduate school students encourage women, under-represented minorities, and persons with disabilities to pursue careers in science and technology.*
- *Internships—Ames will continue to use a variety of paid internship programs to incorporate high school, undergraduate, and graduate school students from diverse backgrounds into the Center workforce.*
- *Employee Groups—The Multicultural Leadership Council (MLC), six advisory groups, and four ad hoc groups are grass root volunteer organizations that nurture diversity in all its dimensions.*
- *Partnerships—The Center is continuing to build partnerships with Historically Black Colleges and Universities, the National Hispanic University, and other minority universities, such as Hispanic Serving Institutions and Tribal Colleges and Universities.*

Moffett Development

The Ames / Moffett complex is 2000 acres of federally owned land under Ames' responsibility with tremendous potential for development within the technology-rich environment of Silicon Valley. In FY99, Ames will use the land and buildings at Moffett to strengthen the Agency's leadership roles and support NASA Ames' missions. This will be accomplished through greater partnerships in the fields of astrobiology, information technology, and aerospace technology. This effort will also augment the Center's ability to pursue the Agency's commercialization, education, and outreach goals. Leveraging

resources in pursuit of NASA goals and programs will enhance Ames' reputation as a world-class research and development facility, while increasing the efficiency of Ames' stewardship of Moffett.

Ames' development efforts will be described in the Integrated Development Plan (IDP) for Moffett. The IDP will detail how the Ames / Moffett complex will evolve into a shared-use campus with government, academia, industry, and nonprofit organizations. This will include the development, in cooperation with our city partners, of the California Air and Space Center with a near term focus on teacher / student education. In addition to increased usage of the Field by nongovernment agencies, Ames will continue to pursue partnerships with Federal and state government agencies. The Integrated Development Plan will be formed with the cooperation of local governments to ensure that the plan is as sensitive to the surrounding community as it is sensible for the nation.

Support Functions

A full array of institutional systems support the Ames Center of Excellence, missions, lead Center programs, and other research and technology development activities. These systems encompass a wide range of areas, including the following:

Acquisition/Procurement

Specialists work to maintain the Nation's technical and commercial standing and the Agency's priorities, and to support Center research and operational goals through acquisition management excellence.

Documentation Development

Professional Information Specialists acquire, produce, and distribute scientific, technical, and nontechnical information using traditional and advanced technologies. Services provided include: printing and reproduction, photo and imaging, video production, graphics, publications, and library.

Human Resources

Human Resource Specialists work to attract, enhance, and retain a highly effective workforce, properly balanced to accomplish the Center's various missions. They work closely with Ames supervisors and managers, providing advice and assistance in planning and implementing proactive human resources programs within each organization.

Facilities Maintenance and Operations, Logistics, and Supplies

Support is provided through two primary functions: 1) institutional facilities, base operations, and maintenance; and 2) supply and logistics services. In addition, as host for the Ames Moffett Complex, the necessary infrastructure and building maintenance is provided to support office space and military housing utilized by Resident Agencies.

Information Technology Services

Services include the development and maintenance of a secure, state-of-the-art computing infrastructure that can support researchers throughout NASA and the world. This infrastructure consists of networking, desktop, and other Information Technology services such as telephones, software repositories, digital audio, and e-mail.

Protective Services

A wide range of emergency and nonemergency services are provided, including security, police, fire, and emergency preparedness. Support includes coordination of Center access for all employees and visitors, security clearance processing, foreign travel briefings for personnel traveling overseas, and physical, technical, and information security throughout the Center.

Hardware Development

Support is provided to the Center's R&D Programs and Projects by developing wind tunnel models for testing; building experimental hardware for spaceflight and airborne experiments; and developing electronic packaging and instrumentation for data acquisition.

Systems Engineering

Ames' missions and program objectives are translated into unique experimental facilities, equipment, instruments, and flight systems through design, engineering, and project and construction management expertise.

Commercialization and Technology Transfer

Timely transition of NASA-developed technologies to the U.S. economy and the effective infusion of appropriate commercial technologies into NASA projects and programs is ensured. Partnerships for the joint development of technology to mutually benefit NASA and industry are promoted. To aid technology transfer and commercialization efforts, a database of technology under development is maintained.

Equal Employment Opportunity

Equal employment opportunity, affirmative employment, and diversity in the workplace are promoted through a variety of mechanisms. Enforcement procedures ensure compliance with existing rules, policies, and mandates.

External Affairs, Outreach, and Education

An extensive array of educational programs, outreach activities, media services, and public relations and informational programs support Center and Agency goals. Many are explained within the foregoing sections.

Financial Systems

Effective, efficient, and economic financial and budgetary systems are developed and maintained to support the Center and Agency customers in line with established goals. High-quality, proactive business services help customers to operate effectively, efficiently, and economically, even with decreasing budgets and increasing requirements.

Office of the Chief Counsel

The Office of the Chief Counsel offers legal advice and assistance to all Ames organizations, and furnishes legal representation for and on behalf of the Center in administrative and judicial proceedings. Members of the Chief Counsel's Office also participate in various Ames management working groups.

Safety, Environmental, and Mission Assurance

A safe workplace, responsible stewardship of the environment, and reliable quality systems are promoted. Support includes effective advocacy, technical consultation, policy guidance, oversight training, regulatory interface, and risk assessment.

VI. FY98 Performance Highlights

Center of Excellence for Information Technology

- *Ames achieved a significant breakthrough in parallel scaling technology, called shared-memory Multilevel Parallelism (MLP). The new technology sustained performance levels of more than 20 GFLOPS on a 35-million-point problem, the largest ever solved at the Numerical Aerospace Simulation facility. This was approximately 4.5x faster than the same problem executed on a dedicated 16 CPU C90 system. The significance of this breakthrough is that legacy code can be parallelized for high-performance, nonvector machines and made to perform efficiently.*

- *NASA and Stanford jointly established the National Center for Biocomputation to develop and apply new 3-D imaging technologies to a variety of medical applications. A virtual institute was created at Stanford University to expand the use of advanced imaging capabilities among the nation's medical and scientific communities. Imaging software developed by Ames scientists will be provided via the internet to doctors and medical centers throughout the world.*

- *The Intelligent Flight Control research program was awarded two technology patents for industry-leading developments in neural net-based adaptive flight control for accident recovery, aviation safety, and enhanced design. Successful simulator demonstrations were documented in FY98 and the final phase flight test at Dryden Flight Research Center (DFRC) is pending availability of the F-15 ACTIVE.*

- *The Independent Verification and Validation (IV&V) Facility was awarded a contract to perform an independent assessment of the criticality and risk associated with selective Command Launch Checkout System (CLCS) software subsystems for the Space Shuttle program at Kennedy Space Center. Results of Ames' criticality assessment also led to independent verification and validation of major CLCS software subsystem components.*

- *The Fatigue Countermeasures Program successfully demonstrated the effectiveness of the naturally occurring hormone melatonin in aiding sleep in space. The experiment was conducted on four payload specialists on the Neurolab (STS-90) mission. This research is likely to benefit astronauts and individuals with a high incidence of insomnia (e.g., shift workers, the elderly, and flight crews and others who frequently travel across time zones).*

- *In FY98, the Deep Space-1 (DP-1) Remote Agent Project was successful in integrating Remote Agent components, including novel algorithms for efficient plan execution; porting the Remote Agent to the real-time, flight-like, computational environment; and pre-integrating DS-1 with flight software. The DP-1 Remote Agent, jointly developed by Ames Research Center and the Jet Propulsion Laboratory, is an on-board agent architecture for autonomous spacecraft that integrates constraint-based temporal planning and scheduling, robust multi-threaded execution, and model-based mode identification and reconfiguration.*

Mission in Astrobiology

- *Ames established a management office and began operation of the NASA Astrobiology Institute. In numerous workshops, Ames scientists worked with over 100 members of the diverse astrobiology research community to define a roadmap for the new NASA Astrobiology Program.*

- *The Ames proposal for interdisciplinary research in astrobiology was selected by the Office of Space Science, making Ames one of 11 initial members of the new NASA Astrobiology Institute. The proposed work involved scientists from across the Space, Earth, and Life Sciences, both at Ames and in collaborating institutions.*

Aero-Space Technology Enterprise

- *Ames developed two air traffic management tools for implementation at air traffic control facilities in Dallas, Texas. These tools, which aid air traffic controllers in sequencing and scheduling aircraft on approach and landing, increased airport capacity by up to 10 percent and reduced delays by an average of 3 minutes. The software associated with the air traffic management tools was the recipient of the NASA 1998 Software of the Year Award. Additionally, the FAA has selected these tools for accelerated implementation into a number of airports throughout the United States as part of the "Free Flight Phase I" National Airspace System modernization program.*

- *Results of the first flight demonstration of a Sharp Ultra-High Temperature Ceramic Nosetip were analyzed and released (to an ITAR restricted audience). The first hypervelocity flight of a 0.141-inch radius nosetip achieved temperatures exceeding 5000 degrees F. The successful material performance achieved during this flight demonstrates the applicability of these materials for reusable sharp leading edges on hypersonic vehicles, enabling a multitude of new design options for improving cross range and lift to drag ratios.*

- *Ames developed a complex geometry flow analysis package, which included the Overflow Computational Fluid Dynamics (CFD) code that is*

being used to demonstrate Navier–Stokes CFD capability for high-lift configurations. This code was selected as a runner-up for the NASA 1998 Software of the Year Award.

- *A major Short-Haul (Civil Tilt-rotor) project milestone was reached by the successful completion of wind tunnel testing using the Ames-developed Tilt-Rotor Aeroacoustic Model (TRAM) at the Deutsch-Niederlandischer Windkanal (DNW). The objective of the test was to acquire 1/4-scale V-22 isolated rotor acoustic and airload data to enable the development of quieter, next-generation proprotors.*

- *The X-36, a remotely piloted, 28-percent-scale next-generation fighter configuration, flew 31 successful flights demonstrating high fly rates and excellent reliability. The flight program clearly showed that the X-36 possesses agility that exceeds the capability of today's top fighter aircraft by significant margins.*

Space Science Enterprise

- *The Lunar Prospector Discovery Spacecraft was completed, launched, and successfully operated in lunar orbit during FY98. Initial science results include strong evidence for water ice in cold traps near both poles of the Moon. Lunar Prospector is a partnership between Lockheed Martin, the Lunar Research Institute, and Ames Research Center.*

- *The Stratospheric Observatory for Infrared Astronomy (SOFIA) Project completed both wind-tunnel simulations and baseline flight tests using the Boeing 747 aircraft in order to complete the preliminary designs for the observing cavity door design and all other aircraft modifications. SOFIA is scheduled to begin flights with a 2.5-meter telescope (provided by Germany) in 2001.*

Human Exploration and Development of Space Enterprise

- *Ames managed the development and flight of 15 of the 26 experiments aboard Neurolab (STS-90). The experiments accomplished the first measurements of brain cell function in the absence of gravity, the first studies of neonatal development in space, and the first use of anesthetics and survival surgery in microgravity. Neurolab was the most complex and sophisticated Life Sciences mission ever flown by NASA.*

- *Ames, working under the leadership of JSC, completed negotiations with NASDA concerning the technical requirements for the Space Station Centrifuge and Glovebox. It was agreed that the Japanese will provide critical components of the gravitational research facility onboard the International Space Station and that NASA will provide launch services for the Japanese Experiment Module (JEM) and associated hardware.*

Earth Science Enterprise

- *Direct measurements of cloud properties made as part of the Subsonic Aircraft Contrail and Cloud Effects Special Study (SUCCESS) demonstrated the evolution of aircraft contrails into cirrus clouds, revealing a new mechanism for the impact of aircraft flights on the Earth's climate. Large regions of the upper troposphere were observed to be supersaturated but did not form clouds unless aircraft flew through them.*

Initiatives

- *The Aeronautical Test and Simulation Division became the first organization at Ames to become ISO 9001 certified, assuring that simulator and wind tunnel customers receive world-class quality services at the Center.*

Support Functions

- *Ames succeeded in transitioning the Center to a smaller, reorganized workforce in FY98. This transition was accomplished using buyouts and targeted hiring to better meet Ames' missions. A particular focus in FY98 was the transfer of the Flight Operations function to DFRC. The Human Resources Division successfully implemented this objective within a tight time constraint and without a single adverse personnel action.*

- *Ames initiated the development of Moffett Federal Airfield in FY98 by signing partnerships with numerous government, nonprofit, and private organizations that share common goals with NASA. These partnerships allow Ames to leverage its resources to enhance Ames' ability to support NASA goals.*

- *In FY98, Ames conducted a comprehensive study of facility space utilization to develop a space management plan for Ames. The goals of this plan are to improve space utilization, reduce operating life cycle costs, and better align the Center's facilities with current and future missions and programs.*

- *Ames converted eight major contracts to Performance Base Contracts in FY98, exceeding the Agency metric.*

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ACRONYMS

AIRES	Airborne Infrared Echelle Spectrometer
ALS	Advanced Life Support
AOS	Aviation Operations Systems
ARC, or Ames	Ames Research Center
ASC	Aviation System Capacity
AT	Aero-Space Technology Enterprise
ATD-B	Advanced Technology Development Biosensors Program
AVOSS	Aircraft Vortex Spacing Separation
CAMEX	Correction and Moisture Experiment
CAS	Computational Aerosciences Project
CASC	California Air and Space Center
CCU	Cell Culture Unit
CFD	Computational Fluid Dynamics
CHAART	Center for the Health Applications of Aerospace-Related Technologies
CIC	Federal Computing Information and Communications Program
CIO	Chief Information Officer
CLCS	Command Launch Checkout System
CMEX	Center for Mars Exploration
CNS	Communication, navigation, and surveillance systems

COE-IT	Center of Excellence for Information Technology
CoSMO	Consolidated Supercomputing Management Office
COTS	Commercial off the shelf
CSA	Canadian Space Agency
CTAS	Center terminal radar approach control (TRACON) Automation System
CTR	Civil tiltrotor
DEAR	Design for Efficient and Affordable Rotorcraft
DFRC or Dryden	Dryden Flight Research Center
DGPS	Differential Global Positioning System
DLR	Deutsche Forschungsanstalt fur Luft-und Raumfahrt, Germany
DOD	Department of Defense
DROM	Dynamic Runway Occupancy Measurement
DS-1	Deep Space One mission
EOS	Earth Observing System
ERC	Educator Resource Center
ESS	Earth and Space Sciences Project
FAA	Federal Aviation Administration
FIRE	First International Cloud Climatology Regional Experiment
FRIAR	Fast-Response Industry Assistance Requests Project
FY	Fiscal Year
G&A	General and Administrative
GB&E	Gravitational Biology and Ecology Program

GIS	Geographic Information System
GSFC, or Goddard	Goddard Space Flight Center
HEDS	Human Exploration and Development of Space Enterprise
HEPM	Hazardous Environment Prediction and Mitigation
HHR	Habitat Holding Rack
HPC	High-Performance Computing
HPC	Human Performance and Countermeasures
HPCC	High-Performance Computing and Communications
HSO	Hungarian Space Office
HST	Hubble Space Telescope
IDP	Integrated Development Plan
IDS	Integrated design system
INC	Incubator habitat
IR	Infrared
IS	Intelligent Systems
ISO	International Standards for Organization
ISRU	In Situ Resource Utilization
ISS	International Space Station
IT	Information Technology
ITS	Information Technology Security
ITT	Integration Task Team
IVHM	Integrated Vehicle Health Management

IV&V	Independent Verification & Validation
JASON	(A name, but established as all capitals.)
JEM	Japanese Experiment Module
JPL	Jet Propulsion Laboratory
JSC, or Johnson	Lyndon B. Johnson Space Center
KSC, or Kennedy	John F. Kennedy Space Center
LARC, or Langley	Langley Research Center
LBA	Large-Scale Biosphere Atmosphere project
LeRC or Lewis	Lewis Research Center
LES / DNS	Large eddy simulation / Direct Numerical Simulation
LSG	Life Sciences Glovebox
LT	Learning technologies project
MLC	Multicultural Leadership Council
MLP	Multilevel Parallelism
MMMD	Micro Mass Measurement Device
MSFC, or Marshall	George C. Marshall Space Flight Center
NACA	National Advisory Committee for Aeronautics
NAI	NASA Astrobiology Institute
NAS	National Airspace System
NASDA	National Aerospace Development Agency of Japan
NAVOCEANO	Naval Oceanographic Office, Stennis Space Center, Mississippi

NGI	Next Generation Internet
NGST	Next Generation Space Telescope
NRA	NASA research announcement
NREN	National Research and Education Network
NRRA	National Rotorcraft Research Alliance
NRTC	National Rotorcraft Technology Center
NTSB	National Transportation Safety Board
OAT	Office of Aero-Space Technology
OES	Office of Earth Science
OLMSA	Office of Life and Microgravity Sciences and Applications
ONR	Office of Naval Research
PC-ITS	Principal Center for Information Technology Security
PIs	Principal investigators
PKI	Public Key Infrastructure
REE	Remote Exploration and Experimentation Project
R&T	Research and Technology
RLV	Reusable Launch Vehicles
SAFOR	Safe All-Weather Flight Operations for Rotorcraft Project
SDAR	Systems Design, Assessment, and Reliability
SFG	Simulation Facility Group
SHEBA	Surface Head Budget of Arctic Ocean
SILNT	Select Integrated Low-Noise Technologies Project
SMMD	Small Mass Measurement Device
SOFIA	Stratospheric Observatory for Infrared Astronomy

SONEX	Subsonic Assessment Ozone Nitrogen Experiment
SSBRP	Space Station Biological Research Project
STOVL	Short Takeoff Vertical Landing
SUCCESS	Subsonic Aircraft: Contrail and Cloud Effects Special Study
TAP	Terminal Area Productivity
TARFOX	Tropospheric Aerosol Radiative Forcing Observational Equipment
TERPS	Terminal Procedures
TPS	Thermal Protection System
TRC	Teacher Resource Center
TRACON	Terminal Radar Approach Control
TRAM	Tiltrotor Aeroacoustic Model
TRMM	Tropical Rainfall Measuring Mission
USRA	Universities Space Research Association
UV	Ultraviolet
WRESAC	Western Region Earth Science Applications Center